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THE EQUIPMENT AUTHORITY

JUNE 1993

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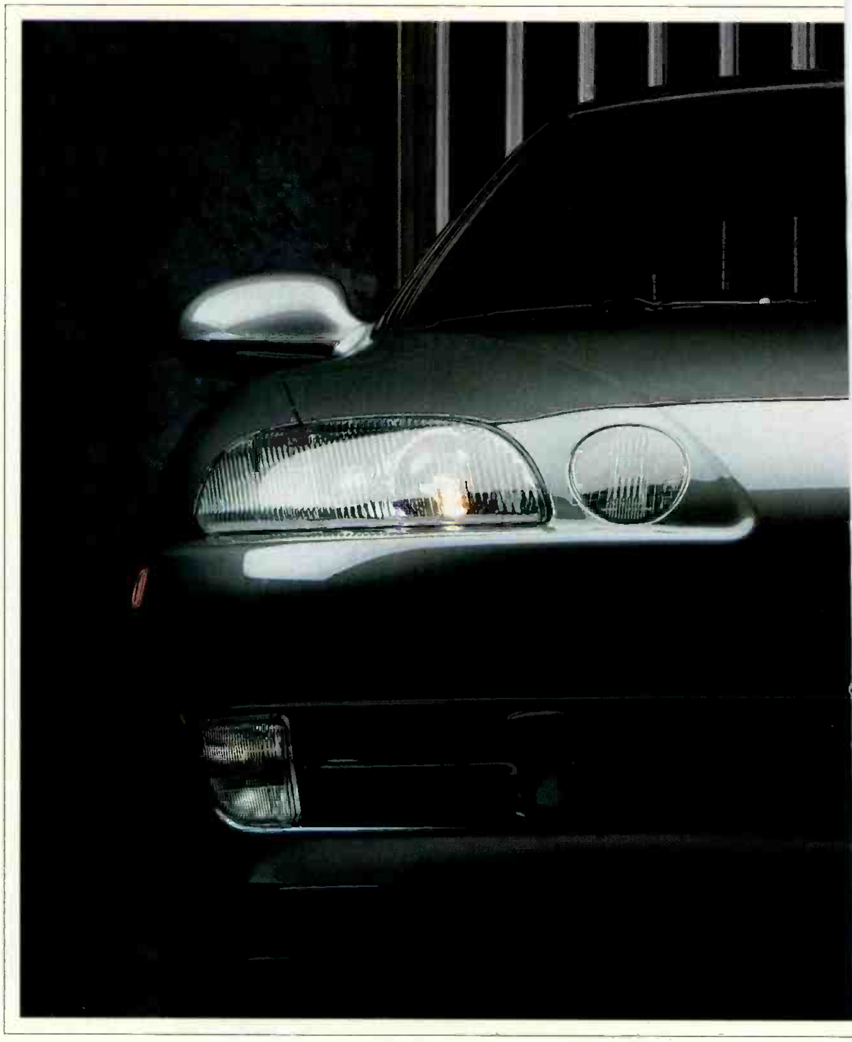

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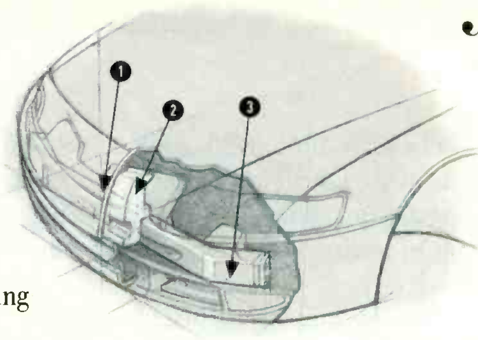

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JUNE 1993 VOL. 77, NO. 6

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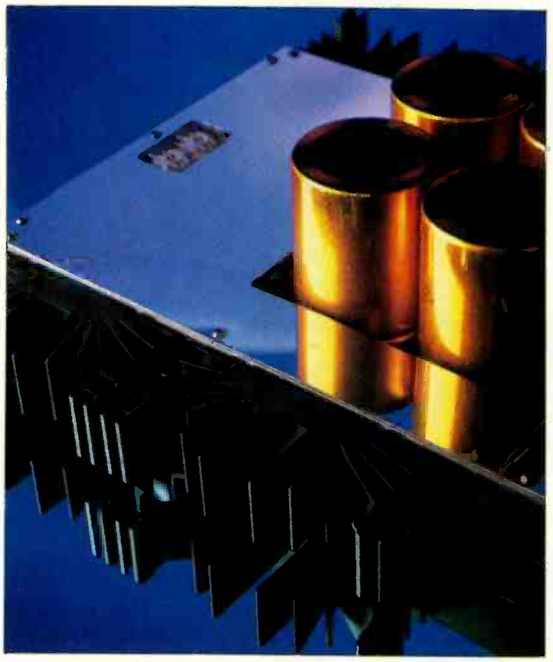
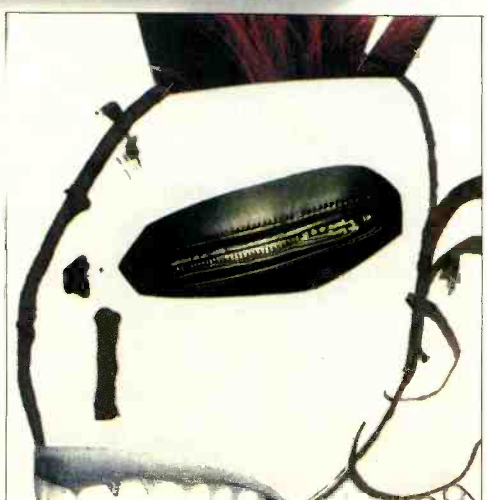
Tape Test, *page 38*



Metaxas, *page 62*

Currents, *page 26*



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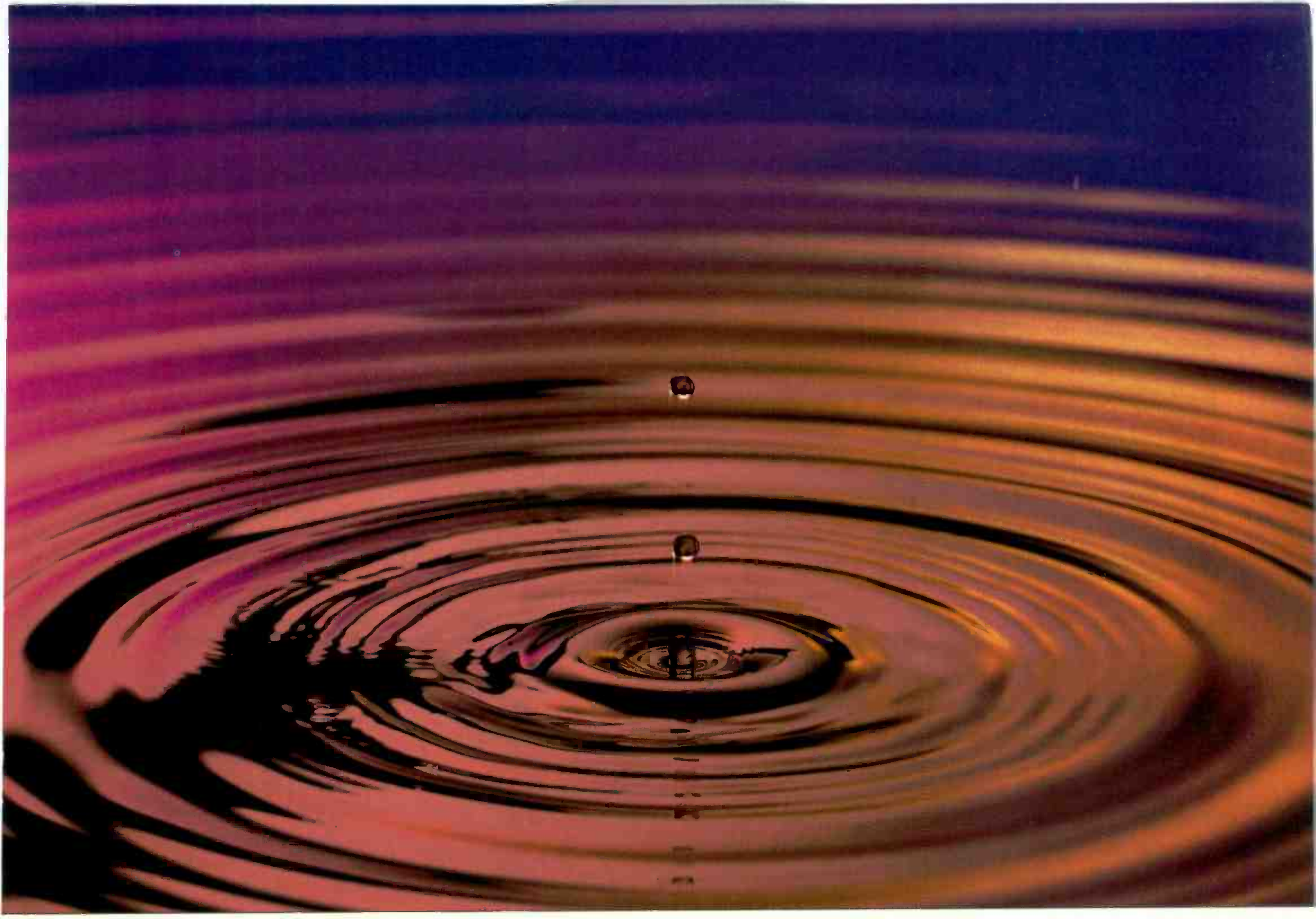

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FAST FORE-WORD

There was a very interesting story in the March 27th issue of *Billboard*, which to my mind is the music/recording industry's leading trade publication. The headline read, "Warner to Hold Artists' Digital Royalties: Would Claim Monies As Reserves Against Advances." These royalties were discussed in December 1992 and are a product of the Audio Home Recording Act President Bush signed into law last October 28.

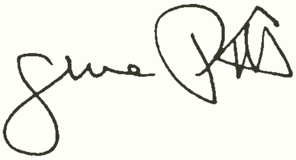
Just to refresh your memory, the law provides for a 3% royalty on the factory price of blank digital media, such as MiniDiscs and Digital Compact Cassettes, as well as a 2% tax on the factory price of digital recorders ($1 minimum and $8 maximum). This money is to go to performers, songwriters, record companies, and music publishers. In addition, all consumer recorders are to include Serial Copy Management Code circuitry. The idea is that the above groups are to be compensated for copies made with these great new recorders, copies virtually indistinguishable from the originals.

Now, to understand the *Billboard* story, you need to understand a bit about the financial arrangement most musicians have with their labels—specifically, they usually have an account against which are charged various items such as walking-around money, studio time, promo costs, beer after concerts on the road, and so forth. On the other hand, record sales, in the form of royalties paid in the manner usual for many decades, add to the account. Too often, these accounts are never in the black. I hesitate to use the ratio of black to red accounts as an indicator of how good the label is in assessing talent or marketability. Fairer, I think, is the percentage of Big Hits on the average full-length CD.

What the Warner Music Group is attempting to do, says *Billboard*, is collect those digital royalty monies, which are a new form of royalty stream, and apply them to these accounts between musicians and the various Warner record labels. The story goes on to quote industry attorneys to the effect that the practice would run counter to the intent of Congress in the Home Taping Bill. Noting that at present only Warner is attempting such a move, *Billboard* writers Paul Verna and Irv Lichtman quote various attorneys to the effect that the move "is not benign," gives "an unfair advantage," and would cause "some friction."

It also helps to understand this story if you are aware that in today's pop music world, most performers are also the songwriters and that many music publishers are owned by the record companies. The end result of situations like this is that *all* of this new revenue stream will go to the record companies if the Warner technique is followed across the industry.

Is this what Congress had in mind when it passed the Audio Home Recording Act? I don't think so. Is it fair to performers, writers, and other toilers in the trenches? I don't think so. Is Warner going to change without Congress getting involved again? Maybe, but only if a little light is brought to bear on this shady practice.



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If Not Audiophile, *Audio* Defiled?

Dear Editor:

I don't know why Ivan Berger's December 1992 "Roadsigns" review of the Philips DC777 car head unit appeared in *Audio* instead of an affiliated magazine such as *Stereo Review* or *Car Stereo Review.* Mr. Berger himself says, "when a manufacturer leaves both Dolby NR and EQ switching off his tape section, you know he's not aiming the model at audiophiles." If a writer for *Audio* wishes to do an article on car stereo, the products should be in the audiophile category. One may ask, how can the reviewer know the performance level of a product except at the end of testing? So be it—but publish the review somewhere else if it's not appropriate to your magazine.

Also, may I suggest that your editors commission one or more articles relating to pure Class-A solid-state amps. You seem to be avoiding these products.

Furthermore, I have been shopping for a boombox and find that they no longer have Dolby B or C NR or even metal-tape compatibility. Some models have the capability to copy CDs; I always thought that when copying from a CD, one should use Dolby B or C NR and/or metal tape. With prices for boomboxes of higher quality reaching to $300, this is of interest to audiophiles who wish to go portable.

Joseph Birn
Bronx, N.Y.

Editor's Note: The vast majority of car stereo products that *Audio* reviews *are* audiophile products. I made an exception for the Philips because its FM/AM/short-wave tuner fills a unique niche—but you'll notice we gave the unit a brief, informal evaluation in my "Roadsigns" column instead of a full "Equipment Profile" review.

We haven't any policy against Class-A solid-state amps. Consider instead the law of averages: About 90% of all amps don't fit this category. I hope to review some Class-A and tube *car* amps in the next year or so.

As to boomboxes, I agree that Dolby NR and the ability to use metal tape would be desirable—for those *Audio* readers who use such equipment. But the folks who market boomboxes have concluded that the young people who use most of these models don't consider low noise and wide dynamic range to be important.—*I.B.*

JBL L7 Review a Square Deal

Dear Editor:

Thought I would drop you a line to say how much I enjoyed D. B. Keele, Jr.'s review of the JBL L7 loudspeaker (December 1992). I had recently purchased a pair of the L7s, and I found the review to be accurate. Keele was right on target, although I feel that operating the speakers in a bi-wired mode offers better performance. Thank you again for an excellent and informative "Equipment Profile."

B. Mullins
Brockton, Mass.

Errata

We regret that, due to misediting, some errors were introduced into John Sehring's "Taking Up Resonance: Finding Room Modes on Your Computer" (April). These included both a typographical error in Line 120 of the program listing and a misstatement of how room size affects subwoofer performance and thereby selection.

A corrected version of Line 120 appeared in our May issue; the entire program is reprinted here. Note that in the April issue several lines were broken to fit the column; the Enter or Return key should not be pressed at these breaks, only at the end of each numbered line.

We received letters about the article itself from Thomas D. Rossing, Professor of Physics at Northern Illinois University, David Moran, and Tom Nousaine. We are printing one from Professor R. A. Greiner of the Department of Electrical and Computer Engineering at the University of Wisconsin–Madison, and a note from the author.—*E.P.*

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As I get older and more mellow, I write less and less to magazines about errors. But

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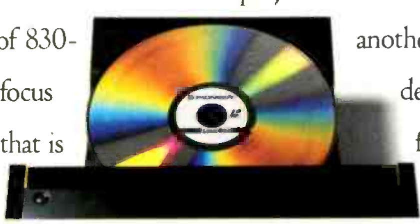

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BY PIONEER

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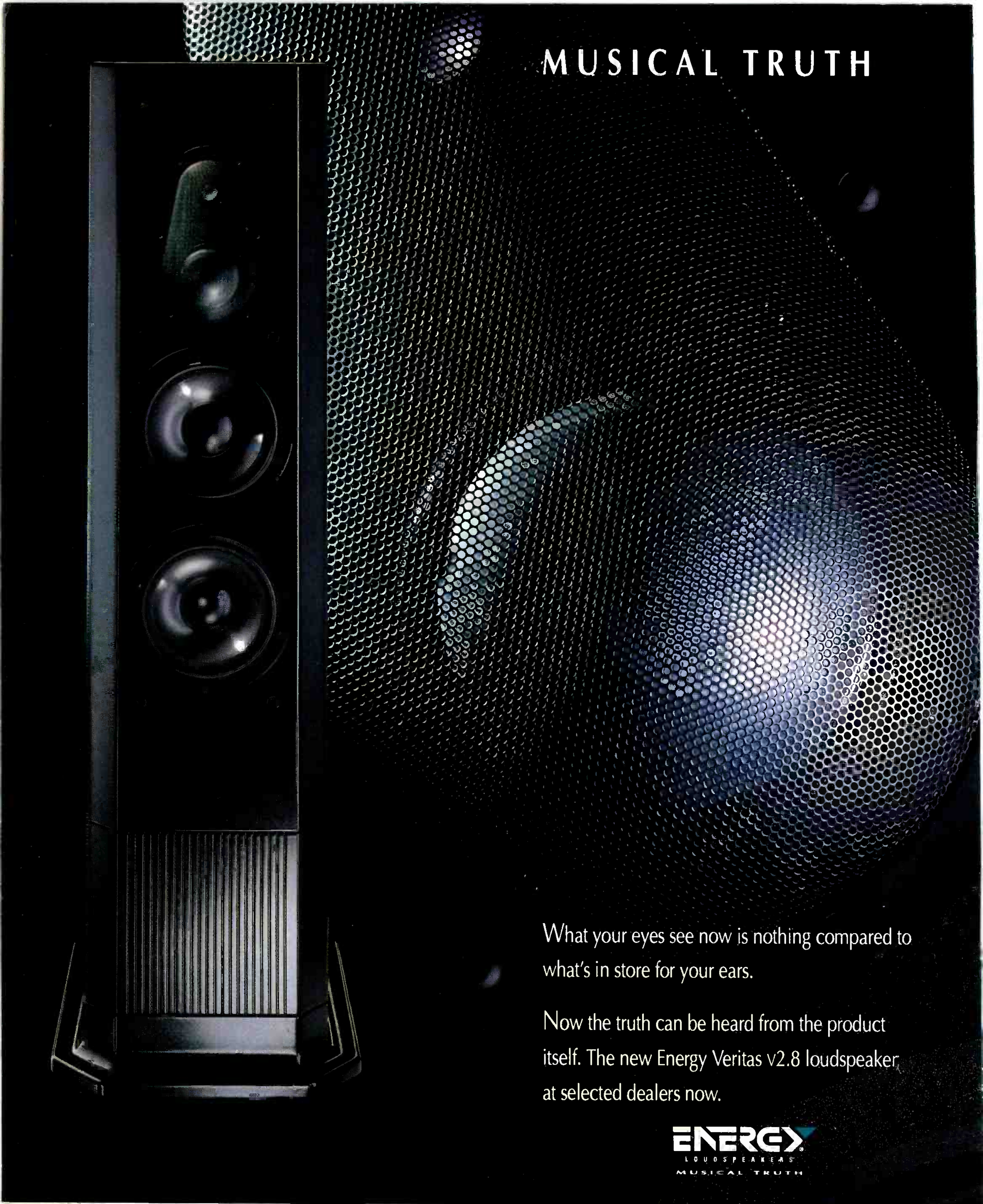
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What your eyes see now is nothing compared to what's in store for your ears.
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MUSICAL TRUTH

from time to time the error is so bad that I must speak out. Unfortunately, this time it occurs in *Audio.* (Boo hoo!)

The error is in the article by John F. Sehring and is stated on page 33, in italics, no less. ("The room's length determines the lowest frequency at which a subwoofer can work efficiently.") Additionally, it is emphasized in a sidebar and, finally, repeated in the last sentence of the article.

It is a common misconception, which has been propagated in some publications, that there is a low-frequency limit to sound reproduction that is somehow related to the room size. This is not true. In fact, the smaller the room, the easier it is to generate high sound pressure levels in the room with a given motion of the subwoofer piston. This fact is especially true for the very low frequencies. Below the frequency of the lowest standing wave, which is the 1,0,0 mode, there are of course an infinity of frequencies, going down to d.c. if you like, that excite the room more and more as though it were a compliant chamber. Just because the waves don't fit in the chamber (room) does not mean that they do not excite the chamber.

In fact, the volume velocity of the piston excites the chamber as though it were principally a compliance. Thus, the pressure in the chamber increases as the frequency gets lower for a constant volume velocity from the piston. It is the pressure, which is now mainly uniform throughout the chamber, which the ear hears. If you do not think this to be the case, try measuring the pressure inside a loudspeaker cabinet. The audible sound pressure level is very high indeed. This phenomenon is clear and obvious both from appropriate acoustical models as well as common experience.

I suggest that [if you] put a subwoofer in a closet, you will soon find the low-frequency sound pressure in the closet to be very loud indeed, despite the fact that the closet might have a 1,0,0 mode frequency of several hundred hertz. Or consider the high-level low-frequency sound you can get with a closed-cup headphone. In this case, a very tiny piston motion (volume velocity) causes very high sound pressure levels within the earcup and thus very loud sound. The closed-cup headset depends upon this phenomenon to generate high-level low-frequency sounds. When the cup is lifted slightly, causing a leak, the lows go away.

[However, Sehring's] mode calculations and other information in his article are accurate and useful.

R. A. Greiner
Madison, Wisc.

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TABLE III REPLACEMENT, APRIL 1993, PAGE 35

```
1 REM: PROGRAM COMPUTES FREQUENCIES OF NORMAL ROOM MODES
10 CLS
20 PRINT "INPUT ROOM LENGTH, WIDTH & HEIGHT (IN DECIMAL FEET), SEPARATED BY COMMAS:"
30 INPUT L, W, H
40 PRINT
50 PRINT "MODE (L,W,H)"; TAB(15); "FREQ(HZ)"; TAB(41); "MODE (L,W,H)"; TAB(55); "FREQ(HZ)"
60 FOR I = 0 TO 2
70 FOR J = 0 TO 2
80 FOR K = 0 TO 2
90 FREQ = 571 * SQR((I / L) ^ 2 + (J / W) ^ 2 + (K / H) ^ 2)
95 FREQ = INT(FREQ + .5)
100 PRINT I, J; K, FREQ;
110 COL = COL + 1
120 IF COL = 2 THEN COL = 0: PRINT  ELSE PRINT TAB(41);
130 NEXT K
140 NEXT J
150 NEXT I
160 PRINT : PRINT
170 PRINT "(TO PRINT, PRESS SHIFT & PRT-SC KEYS TOGETHER WITH PRINTER  ON LINE)"
```

There are other important factors besides frequency response in subwoofer selection, such as phase response, distortion, efficiency, and acoustic power output capability. In general (but not always) a speaker with a lower –3 dB frequency cutoff has the potential to have improved characteristics in these areas. . . .

A speaker supplies maximum power to a room when its acoustic impedance is matched to that of the room. Since it is usually high, the speaker can supply maximum power when the room impedance is high. This occurs when (by definition) the ratio of sound pressure to particle velocity is high, as when a speaker is located at a room-mode pressure maximum. Then the speaker's ability to *efficiently* transfer power to the room is at a maximum.

Irrefutable fact: No resonance pressure maximum occurs below the 1,0,0 frequency of a room. *Efficient* generation of sound below this frequency from sources that are small in terms of the wavelength (the kind of sources most of us have) is therefore more difficult, not impossible. . . . With usual speakers in ordinary rooms, modal enhancement is very useful and efficient, but it has a lower frequency limit.

The statement that "there's not much sense paying for a 10-Hz subwoofer in a 29-Hz room" was not in my manuscript. What I did say was that "A subwoofer whose frequency response rolled off below 29 Hz would be adequate to excite the lowest frequency [mode] in this room"—adequate, not the best or unimprovable.

As a service to *Audio* readers, I am offering the software described in my article "Taking Up Resonance: Finding Room Modes on Your Computer" (April) on floppy disk. On the disk is an enhanced version of the original program, which was too lengthy to appear in the article. It includes graphics to show individual and combined room modes, room frequency spectra and response, frequency space plots, location of resonance peaks and nulls in a room, and the effects of loudspeaker and listener placement.

The program is supplied on a 5¼-inch floppy disk. It runs on IBM-compatible personal computers using MS-DOS 2.1 or later. Video capability of CGA or higher is required for displaying the graphics. The cost is $15 and is available, postpaid, to the address below.

John Sehring
46 Valley View Terrace
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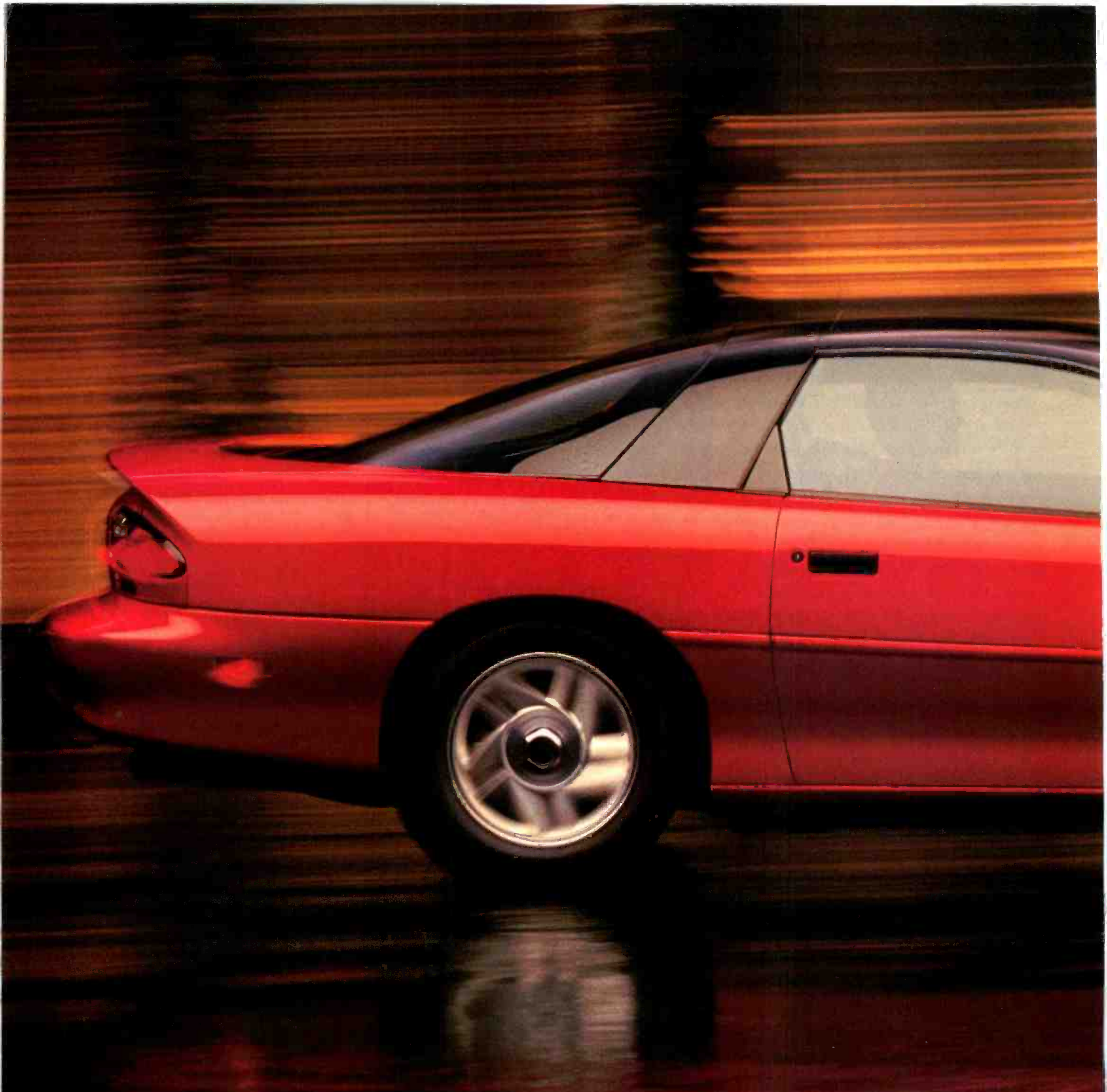

Actually, considering that we're aiming for the highest quality ever, it isn't hard to understand why we build the new Chevy Camaro Z28 the way we do. Each car has to pass the critical eyes of a series of laser cameras that measure the exactness of the dimensions. A team of inspectors who examine the paint under a bank of hot lights for any defects. A sonic test that checks all windows and doors to detect any noise leaks.

And then there are things like a new welding device (called a robogate) that also ensures the dimensional integrity of the body. And a Dynamic Vehicle Test done on rollers at 65 mph to check that the engine, trans-

*Always wear safety belts, even with air bags. †Excludes other GM products. **See your Chevrolet dealer for terms of this limited warranty. ††See your dealer for details of

AUDIO CLINIC

JOSEPH GIOVANELLI

Antenna Isolation Revisited

In the December 1992 "Audioclinic," I described how to build an isolating balun to prevent ground loops between an FM tuner and a cable antenna system, using two ordinary baluns and a pair of capacitors. Unfortunately, I suggested using 50-μF capacitors; Bernard H. Bueffel, of Portland, Oregon, has since pointed out that the value should be 50 pF and that 47-pF ceramic discs should work fine. He also suggests using just the two transformers, back to back, without the capacitors. That won't work for everyone (though it did work for him) because not all 75-to-300-ohm matching transformers are wired alike. If an ohmmeter shows infinite resistance between the 300-ohm side and the 75-ohm side, you won't need the capacitors; if there's a connection between the two sides, you will.—*J.G.*

Turn It Off

Q. *What is better in terms of long life for power amplifiers or preamplifiers: Leaving them on all the time or turning them off when they are not being used? I have two different power amps. The manufacturer of one of these tells me to leave it on all the time; the manufacturer of my other amplifier tells me to turn it off if it is not being used. The opinions of dealers and technicians also differ. What is your opinion?*—Paul R. Morrison, Ft. Smith, Ariz.

A. I realize that we tend to associate leaving equipment on all the time with preserving it. There are sometimes other considerations. I own a power amplifier whose maker instructs me to leave it on all the time; the reason given is that it will sound best this way. Capacitors get fully charged, and correct bias is established in the output stages as they reach and maintain operating temperature. Although this unit sounds fine when operated immediately after it has been turned on, it does sound a bit better if left on.

In most instances, I turn off my preamp and power amp if I do not plan to use them within an hour or so.

Certainly, repeatedly turning an amplifier on and off will result in an excessive number of power-supply surges that will surely shorten the lives of those components. Diodes and capacitors are the vulnerable parts.

How Many Bits in a Second?

Q. *How many bits are required to digitally record 1 S of audio for a CD?*—Name withheld

A. Each sample contains 16 bits. We say that the sampling rate is 44.1 kHz. Translating this into the number of samples recorded in 1 S, there are 44,100 samples. Since there are 16 bits per sample, multiplying the number of samples by the number of bits per sample will give us the answer: 705,600 bits per S for each channel.

Polarity of Separate Speaker Pairs

Q. *When connecting two pairs of loudspeakers to the same amplifier, is it necessary for one pair to be in phase with the other pair?*—Wesley S. Mayeda, Oxnard, Cal.

A. All speakers within a given room that play the same program material must be connected with the same polarity (i.e., be "in phase" with each other). This is especially true if the speakers are very close together, as stacked pairs are. Otherwise, bass tones will cancel each other out and stereo images will be vague and wavery.

If, on the other hand, each pair is located in a different room, a polarity difference between the pairs should not matter. I suppose it could be argued that back e.m.f. voltage could interfere with the performance of the speakers if the pairs were not phased together. However, I have experimented and could not detect any difference in sound quality, with or without coherent phasing between speaker pairs. **A**

If you have a problem or question about audio, write to Mr. Joseph Giovanelli at AUDIO Magazine, 1633 Broadway, New York, N.Y. 10019. All letters are answered. In the event that your letter is chosen by Mr. Giovanelli to appear in Audioclinic, please indicate if your name and/or address should be withheld. Please enclose a stamped, self-addressed envelope.

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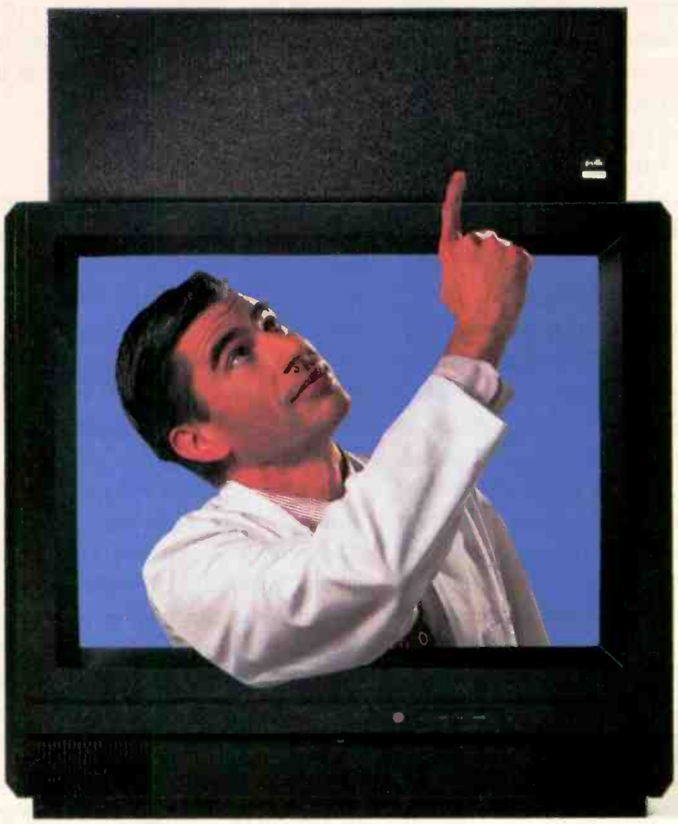

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TAPE GUIDE

HERMAN BURSTEIN

dbx Fans: Don't Despair!

The many complaints this column has run about the absence of dbx noise reduction from consumer cassette decks has prompted this note from Jawxillion Loeb, Product Manager for dbx Professional Products, at AKG Acoustics:

While dbx NR has disappeared from consumer tape decks, the majority of "mini-studio" multitrack cassette units use it. And dbx Professional Products, a division of AKG Acoustics, manufactures an outboard unit, the 140X, which provides two channels of dbx Type II noise reduction, the type used for cassette recorders, at a suggested price of $319. It is sold through professional audio dealers and music stores that carry pro and semi-pro recording equipment. The 140X should be compatible with any currently made stereo cassette recorder and with any tapes previously encoded with onboard dbx. However, since this is a pro unit, it has ¼-inch phone jacks instead of RCA-type phono plugs. Adaptors, or cords with ¼-inch phone plugs, will be needed when connecting a 140X to consumer equipment.

Defective Open-Reel Recording

Q. *I have an open-reel deck, about 12 years old, which hadn't been used for recording in a long time. Recently I tried to make a recording on a previously recorded tape. A rumbling noise was picked up, the VU meters showed a drop, and the previously recorded material was not entirely erased. At my next recording attempt, the situation grew even worse. Now the deck has no recording or erasing capability whatsoever, although the VU meters indicate everything to be working fine. What could be wrong?*—Richard Priore, Mastic, N.Y.

A. You did not indicate whether your deck works satisfactorily in playback, which would assist a diagnosis. Inasmuch as you did not mention playback, I will assume you have no problem there. My guess is that the high-frequency oscillator isn't working. An inoperative oscillator would affect both recording and erasure, but the problem could also lie elsewhere. You need a competent service shop to trace the cause of your problem and cure it.

How Good Are Auto Bias and EQ?

Q. *Are the cassette decks with automatic bias/EQ selectors accurate enough to make premium-quality recordings?*—Anthony Simpkins, Riverside, Cal.

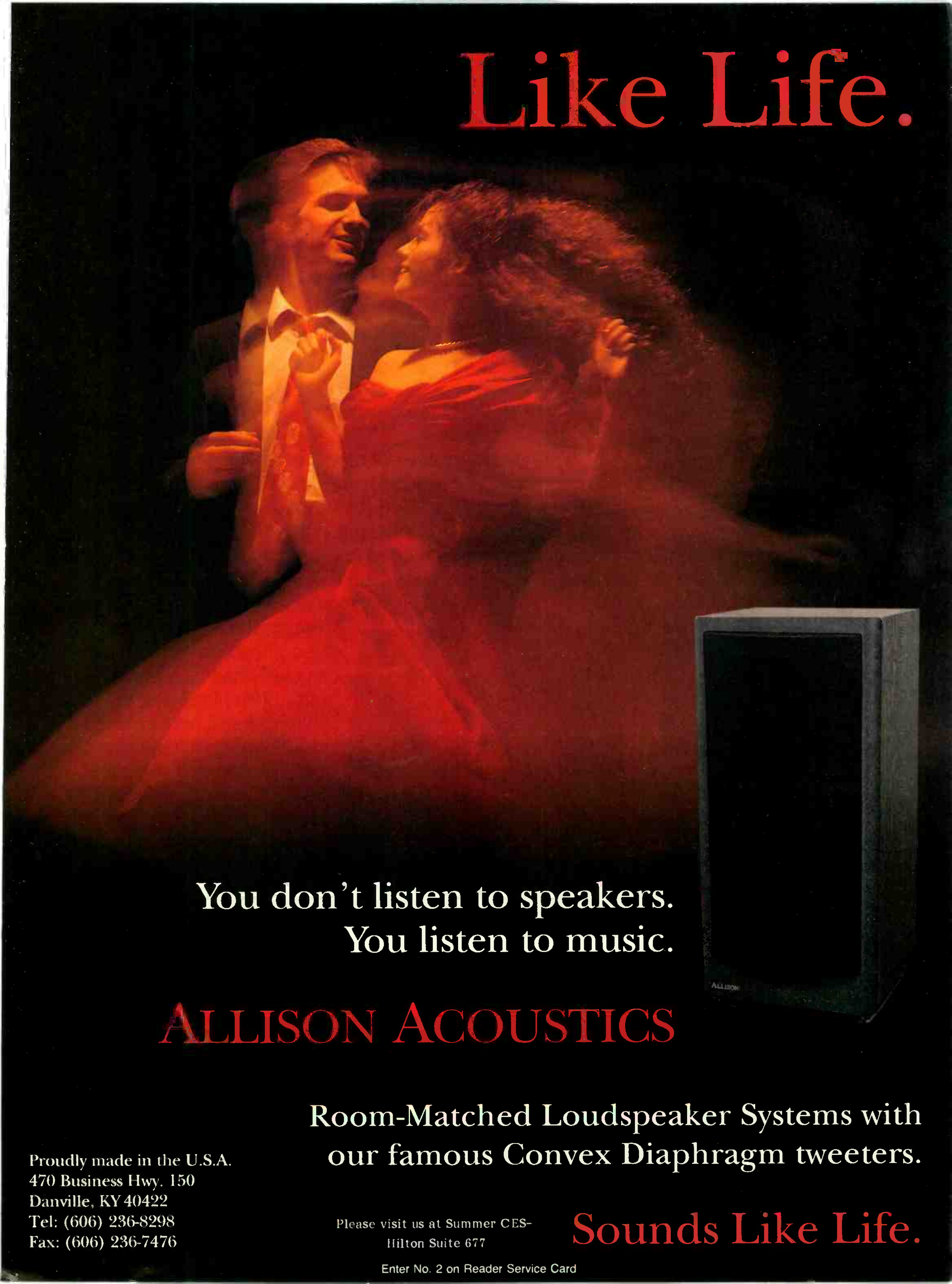
A. Optimum bias for Type IV (metal) tape varies considerably from brand to brand. Therefore, automatic selection of bias may not provide best possible results for metal tape; a deck with user-adjustable bias is preferable in this case. However, the range of variation in required bias is much less for Type I and Type II tapes, so automatic bias selection has a good chance of providing good results. You may see for yourself how much variation in optimum bias exists, within each tape type, in Edward J. Foster's review of 51 tapes in this issue of *Audio.*

"Purifying" a Tape

Q. *A rare LP was recorded for me overseas onto cassette tape. Unfortunately, the recording level that was used was excessive, as can be seen from the playback level indicator of my cassette deck. Mostly, low frequencies of the drum and the vocal group are distorted. Is there anything I can do to "purify" the recording?*—Andrzej Baniukiewicz, Tallahassee, Fla.

A. Unfortunately, once a recording is distorted, there is no way to remove the distortion. The best you can do (and it quite likely won't be very satisfactory) is to de-emphasize the frequency range where the distortion principally lies. In your case, cutting the bass—by means of a bass control in a preamp or receiver or by means of an equalizer—might help a bit. A

If you have a problem or question on tape recording, write to Mr. Herman Burstein at AUDIO, 1633 Broadway, New York, N.Y. 10019. All letters are answered. In the event that your letter is chosen by Mr. Burstein to appear in Tape Guide, please indicate if your name and/or address should be withheld. Please enclose a stamped, self-addressed envelope.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Amazing

EDWARD TATNALL CANBY

BAUBLES, BUCKYS, AND BEADS

Few of us can guess the explosive ramifications that come out of various Big Minds today, more quickly than ever before. Seemingly esoteric discoveries blossom suddenly like the mushroom cloud, changing us more rapidly than we can keep up.

Take a certain Dr. Fuller. Years ago, I attended a lecture by this Dr. Fuller at the University of Oregon—students always call visiting lecturers "Doctor" and "Sir." In his later years, Fuller had taken rather avidly to the college lecture circuits and became a sort of cult figure, drawing great crowds of undergraduates, no doubt to his own satisfaction. He was a good speaker, dramatic, expounding profound ideas with enthusiasm and verve, just what college students love. By the time he had reached Eugene, Oregon, he had been through plenty of other places, improvising his speeches more or less as he went along, as he assuredly did for ours.

For that lecture, a large gym on the Eugene campus was jammed to its rafters with those under 20, plus a few faculty and a handful of ancient souls like me and my hosts. Fuller was late. When we arrived, the acoustic audio had already begun to mount, all too much like a local basketball game, at the same place with the same students. Yells, whistles, screams, catcalls, war whoops, pounding of feet—it's the college way. When Dr. F. finally appeared, surrounded by University dignitaries, the din was indescribable. It took minutes before the man could say a word.

And, for a while, such felicitous words! Each sentence, each spoken paragraph was a polished gem (compared to so many other lectures), minus any script. He was inspired. The cosmos, no less, was all around us. All sorts of heady ideas! And so it went, for an hour or so. But at that point there began a certain stirring and restlessness. Hadn't we heard that idea already, a while ago? Dr. F. was getting hard to follow, gems or no. This was sad, because we began to realize that not only would he go on and on, rejoicing in his own words, but apparently he was not too sure what he had already said to us in *this* lecture.

You can guess the rest. Students have short patience for anything not required on the next exam, no matter how inspired. A few began to walk out. Then more. In no time it became a stampede, right in front of the man, until the big gym was mostly empty except for us older folk and a few students too well brought up to leave so brazenly. It was tragic and embarrassing; I do not remember how it ended and do not want to. That was R. Buckminster Fuller, definitely one of our Big Minds.

Now, of course, you want to know what this has to do with audio. Nothing at all, then, nothing much quite yet. But just wait. You have heard of the geodesic dome that made Dr. Fuller famous, an architectural structure whose geometry was extraordinary, all joined hexagons and pentagons in rigid struts, one of the strongest frameworks ever devised. It was intimately mathematical, too; in a way it was derived mathematically, out of a man's brain, not from nature. Or so it seemed. The geodesic dome lives on, it can be seen, and it is well known all over—enough? Behold, the mushroom cloud.

There is a newly discovered and sensational class of carbon structures now getting around, a new kind of carbon to go along with diamond, graphite, soot. The name

Illustration: Mark McConnell

UNI-Q DRIVER TECHNOLOGY LETS EVERYONE BE IN THE "SWEET SPOT."

You need three front speakers - left, right and center - to achieve realistic home theater, because a stereo pair would place the dialog in the center (where it belongs) from only one listening position. You can't use conventional hi-fi speakers for the center channel, even shielded models, because their dispersion patterns prohibit raising them too high or laying them on their sides.

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for it is *buckminsterfullerene*, shortened, inevitably, to fullerene or buckyball. I expect this is the first scientific discovery to include two of the honoree's names, not just one, like the measurements of volts, watts, amperes, the hertz, the ohm. Why buckminsterfullerene? Because all of these are geodesic domes! Not big airy macrostructures in architecture but infinitely small mini-forms, down in the nano region. This is a mushroom cloud in reverse.

The fullerenes already rank in chemistry along with such as hydrocarbons, the halides, and so on, whole families of related substances with common atomic, molecular, and maybe crystalline structures. There are many variants, and more keep turning up, as micro-production techniques rapidly develop. Flat sheets, sheets curled into seamless tubes, super-round balls (two domes joined), and not-so-round balls, pear shaped more or less. All, now that we have started, with appropriate names—buckyballs, buckytubes. There are super-large fullerene carbon molecules, relatively speaking, C_{60} and C_{70} among them, extremely stable once you have them. And the means for quantity production are appearing—not just a few invisible bits under an electron microscope. More mushroom cloud! The rise of the fullerenes looks already to be like that of aluminum, once a rare and scarce metal in its elemental form, now everywhere.

You want more? *Scientific American* again, back an age or two, October of 1991. The most important fullerene molecule, it seems, is the big, stable, adaptable C_{60}, for it can be put to work in amazing ways, as an insulator, as a conductor, as a "high" temperature superconductor (with no electrical resistance) *and a semiconductor*, with a whole range of dopants. Now you see where we are heading.

As more discoveries proliferate, the C_{60} probabilities prove prolix. And so do the names. Doped with potassium, *bucky* C_{60} becomes a *buckide*, linguistically reminding us of a halide (chloride, bromide, etc.) Now you can grow "films" of C_{60} directly onto such familiar substrates as gallium arsenide, literally joining the new to the old. Getting close to electronics? And K_3C_{60}, known as potassium buckide, is another stable substance, doped, that can be, in turn, grown on pure C_{60}, for the typical multilayer interface of the sort that now rules the electronics world.

All this way back (in terms of today's fast progress) in *Scientific American*, 1991, and more too. For instance, how about the likelihood of *ferromagnetic* properties in the fullerenes, with a complete absence of metal? Tape people, please note. There are fluoride bucky types, in this case useful to us mainly as lubricants—$C_{60}F_{60}$ gets the name of Teflon balls, they being again down on the nano scale. Ball bearings? Or maybe roller bearings, out of bucky Teflon tubes? Rush to your library and read all about it (October 1991). Oh yes—how about buckypears, big C_{60} molecules with a single doped-in atom *inside* the cage? Who knows what that might produce.

THE RISE OF FULLERENE LOOKS TO BE LIKE THAT OF ALUMINUM—ONCE RARE, NOW EVERYWHERE.

We aren't finished yet. Remarkably, though not exactly relevant to audio, is the discovery of living bucky-animals, or ex-animals. They were pictured as far back as 1917, but only now is it obvious that they are no less than living geodesic domes, characteristically made of hexagons and pentagons. Big Minds like Buckminster Fuller have a way of sensing things ahead (and behind), where others miss. Note that the outstanding characteristic of the Fuller dome is the unique mixture of five-sided and six-sided geometrical shapes, the most curious mathematical aspect being that there are always just 12 pentagons, no matter how many hexagons, in each discrete shaping.

So much for Bucky and the fullerenes, but we have gone further in related lines—we always do. Mushroom cloud. There is an even more radical semiconductor coming up that might eclipse them all—not a fullerene carbon film but a deposited film of *diamond*, no less. The indefatigable *Scientific American* again, updated to October 1992. Most of us think of diamond still as (a) a gem, very costly ("A diamond is forever"); (b) the hardest known material, and (c) as crystals with unique light-reflecting powers. In 1955, GE actually synthesized artificial diamonds, and we all were amazed (the Swedes had done it quietly a couple of years before); soon, there was the industrial diamond, still the same old crystals, more like so much sand, silicone dioxide, but tougher. Diamond dust, diamond sand. Not exactly audio material. There was even a type of blue diamond, touched with impurity, which was desultorily recognized as a doped semiconductor—not important. One does not build a boombox with diamonds. But now, the *deposited film* of diamond! And it can be doped. Nothing much yet. And yet—it looks as though eventually both *p* and *n* types of semiconductor can be laid down in this astonishing form, for a whole new generation of electronic properties and, hence, audio. Don't stand around and wait. It'll be a while.

All sorts of properties are described in detail in this second *Scientific American* article. I only pass on to you one, for a sample: Diamond-film chips would operate best between 100° and 500° C. That's warm! Just this might revolutionize the heat-sink problem. Maybe you could incorporate a space heater in a high-end audio system? But what about summer?

Still not the end, but I must be brief. I'm now a follower of another, quicker mag, *Science News*, which has the virtue (among others) of appearing every week. Now we move—still in the same mushrooming direction—out of all the carbons, whether fullerene or diamond, into a new class of similar tiny bucky-like tubes, polyhedrons again, based on tungsten sulphide, inorganic. The research is from Israel. Let me quote: "Like graphite atoms, tungsten disulphide atoms arrange in layers of parallel honeycomb sheets. Hexagons of tungsten are sandwiched between hexagons of sulphur. A seventh atom lies in the center of each hexagon. Weak forces link the sulphur sheets." So says *Science News* (December 5, 1992; page 389). Doesn't that sound very much like more semiconductor stuff?

Seems our entire electronics world may soon be based on, shall I say, semibuckminsterfullerons. So much for the geodesic dome. A

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LINDA OLSON, HOMEMAKER.

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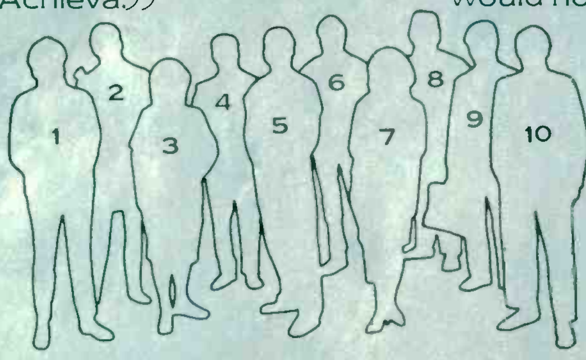
3.
POLLY ANDERSON, MILITARY RESERVE.

“I really enjoyed the Achieva. It just seemed to fit around me.”



4.
CHRIS KNAPP, COMPUTER PROGRAMMER.

“I was impressed with the Achieva. I've had cars before that weren't this good with half as many miles on them.”

5.
ERIC FULLER, MEDICAL STUDENT.

“The Achieva was the most comfortable car I drove during the test. It would be my pick for the best driver's car.”

6.
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“Everybody has the philosophy that Honda makes the best car. I think that Oldsmobile made the best car out of all the cars we tested.”

7.
BETTY CINA, CAR RENTAL COMPANY OWNER.

“In our rental fleet we have all sorts of cars and I think the Achieva would hold up really well.”

8.
RICH MATHERS, GRAPHIC ARTIST.

“The Achieva restored my sense of what an American car should be.”

9.
TROY VALLADARES, MANAGEMENT TRAINEE.

“The Achieva definitely had more than I expected. It still felt like a new car even after 100,000 miles.”

10.
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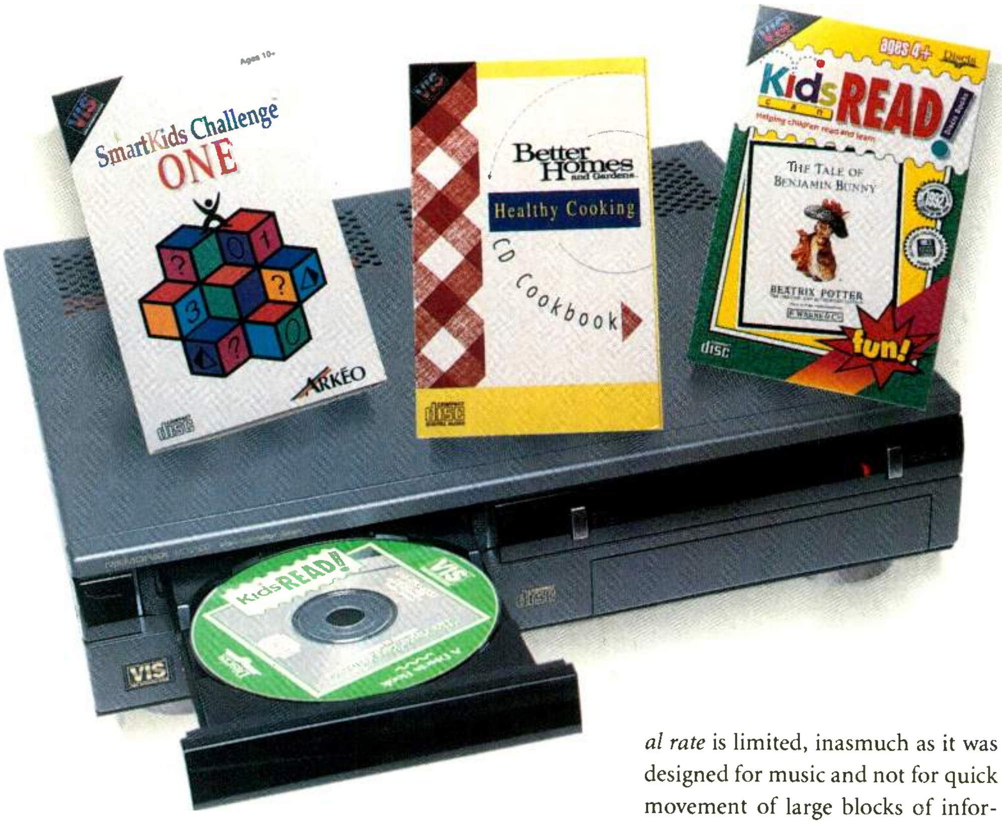
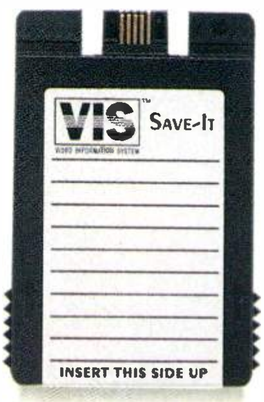
JOHN EARGLE

WE'RE OFF TO SEE THE VIS



The general term "multimedia" has no clear definition. It may mean one thing to somebody in the entertainment industry and something quite different to a consumer. For the latter, it refers generally to one of several information/entertainment systems based on CD-ROM (Compact Disc-Read Only Memory), a dedicated playback/processing unit, and a TV set.



The CD has become the basis for these systems, since it is relatively cheap and can store a prodigious amount of information. But there are problems with the CD as applied to purposes other than music retrieval. First, its basic information *retrieval rate* is limited, inasmuch as it was designed for music and not for quick movement of large blocks of information. Second, it cannot jump from sector to sector with great speed. By comparison, the hard disk drive in your computer has been designed to read out information at a much greater rate *and* move quickly from one sector to another—and it is priced accordingly. (*Editor's Note:* The latest CD-ROM drives from some sources can spin at double speed when reading non-audio data.—*I.B.*) Thus, one of the challenges in programming for a multimedia system based on CD-ROM is to work around these limitations so that the user interface appears smooth and free of gaps.

Tandy's Video Information System (VIS) is a variation on the theme of CD-ROM married to a TV set. While the earlier Philips CD-I and Commodore CDTV formats have not fared particularly well, it seems to me that VIS may do better, because it is easier to operate, addresses itself basically with information retrieval, and is supported by a considerable library of discs, most of them aimed at children.

The Memorex MD-2500 VIS player, which costs $399, hooks to your TV set's antenna terminals; its output is seen on channel 3 or 4, whichever is unused in your area. It is operated by a remote control that is fairly simple to learn—basically, four buttons and a cursor control. Like the other systems, VIS also accommodates standard Compact Discs.

I had about 30 program discs to choose from, priced from $19.95 to $79.95, but probably did not look at more than 10 or 12 in the course of my exposure to VIS. Among the easiest to use is the *Kids Can Read* series issued by Discis Books. This set of children's stories shows both text and picture on the screen. In normal operation the story is read straight through, with text highlighted as it goes. You can pause at any point and then move the cursor to any word on the screen. When that is done, the word is pronounced slowly, presumably so that the child can study it phonetically. Holding the button down a bit longer brings forth a short spoken definition of the word for clearer understanding.

Even though they allow the user certain customization options, these Discis programs are straightforward enough so that there are rarely any gaps in operation. Even the definition of a word comes up quickly when you call for it, as if definitions are carried right along with the text so that the system doesn't have to search elsewhere on the disc for them. Some of the other catalog items are not quite as good in this regard, especially those that lack a story to tell or any other "linear" aspect. *Compton's MultiMedia Encyclopedia*, which comes with the MD-2500 (and is listed as "a $599 value" in a VIS software catalog) is a good


MITSUBISHI

The MD-2500 VIS player by Memorex uses a game-style remote control to access data.

example of this. Access times as new data is loaded in can be annoyingly slow, though looking things up electronically is still faster than handling a traditional encyclopedia and looking things up in it. But because there are too many topics for quick selection from a menu, you must either scroll through a list of all topics beginning with a given letter or enter the topic's title manually. When using the remote, manual entry (or selection of the initial letter for a scrollable list) involves letter-by-letter entry with the cursor control, stretching the limits of what a game-type remote was ever conceived to do.

Those programs that have audio and video segments have generally been done well, with only minimal visual artifacts. The still pictures are, of course, excellent. Almost all of the programs have detailed booklets that present, to a greater or lesser extent, some kind of tutorial on how to use that program with the remote control. One such detailed explanation is given in the booklet for *Better Homes and Gardens Healthy Cooking.* This cookbook on disc contains a click-by-click run-through of just how the program works—clear enough, in fact, that you need no previous exposure to VIS to view the program effectively.

VIS DOES BETTER WITH PROGRAMS THAT TELL A STORY OR HAVE ANOTHER "LINEAR" ASPECT.

One of the problems with purchasing a multimedia system at this time is the lack of compatibility between the various systems. Many of us can recall, about 15 years ago, when digital recording was just beginning. There were a number of professional standards and several different sampling frequencies, to boot. Today, there are basically two multichannel reel-to-reel digital formats which can communicate with each other; the original formats have died out altogether or have become relegated to specific applications. Something like this may happen in the multimedia field, where the pioneers develop systems based on the technology of the day, only to see these systems made obsolete by future developments. One thing we can say with all but absolute certainty is that future systems will be both cheaper and more flexible. But if you wait until the ultimate one comes along, the child you wanted to enlighten may have grown up and left home. A

BERT WHYTE

SILVER SCENES

Bert Whyte, circa 1950, in the sound room of Concord Radio, Chicago, with Browning, Meissner, and Leak components.

The May issue marked the 46th anniversary of this magazine, and it is with some shock—and a lot of pride—that I note that this issue marks my silver anniversary of writing for *Audio.* Twenty-five years is a long time (sounds even more impressive if you say "a quarter of a century"), and it has been a most fascinating and rewarding journey.

My first "Behind the Scenes" column appeared in June 1968, when the concept of "hi-fi sound and audio components was firmly established and in full flower. Those were the heady times when the audio industry enjoyed a remarkable growth rate, sustained even in the face of political upheavals and war.

Several developments prompted me to cover the state of open-reel prerecorded tapes in my first column. The stereo disc had by then been available for a decade and was steadily eroding sales of 7½-ips stereo tapes. The well-heeled audiophiles still preferred stereo tapes over stereo discs, even though the tape hiss of these pre-Dolby recordings was bothersome. Stereo discs had even more annoying surface noises, suffered from inner-groove distortion (not a problem with tape), and did not have as wide a dynamic range as stereo tapes. However, the 7½-ips tapes were significantly more expensive. In order to make stereo tapes achieve price parity with stereo discs, many record companies issued prerecorded tapes at a speed of 3¾ ips—a definite step backwards in respect to sound quality. Ampex, which operated United Stereo Tapes, was steadfast in its support of 7½-ips stereo tapes; because they issued the classical recordings of the prestigious London, Philips, and Deutsche Grammophon labels, their market was fairly stable. Later, Ampex made 7½-ips tapes with Dolby B noise reduction, affording a significant reduction in tape hiss.

Nonetheless, with continuous improvements in the stereo disc and associated playback equipment, tape sales gradually declined. Ampex eventually shut down UST, and Barclay-Crocker, which valiantly tried to keep the stereo open-reel format alive, finally made their last tapes in 1986. Thus, prerecorded stereo tapes, which had become a market entity with the pioneering RCA tapes in 1954, made their last hurrah just 32 years later.

Back in 1968, the Stereo Eight (8-track) endless-loop tape cartridge had been in existence for three years. As Music Director of RCA Victor's Red Seal Records in 1965, I had produced the first of more than 100 of these cartridges. In August 1968, I reported on this format and the many problems I encountered with these endless-loop tapes and their four interleaved pairs of stereo tracks. Of course, 8-track was competing with the fledgling Compact Cassette. Both formats were targeted to the mass market, and in 1968, 8-track cartridges were flourishing in the automotive market. In a follow-up column in the January 1969 issue, I mentioned that RCA had by then produced 8 million Stereo Eight tape cartridges. Ampex was

Every so often, a product is introduced that's so good, it serves as the benchmark for an entire industry. Yamaha's critically acclaimed DSP-A1000 is such a product.

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Other notable features include an on-screen display for sound field adjustment. Seven-channel amplification. Pre-amp outputs on all channels to permit additional amplification. Five audio and six video inputs. And split subwoofer outputs to accommodate two front subwoofers.

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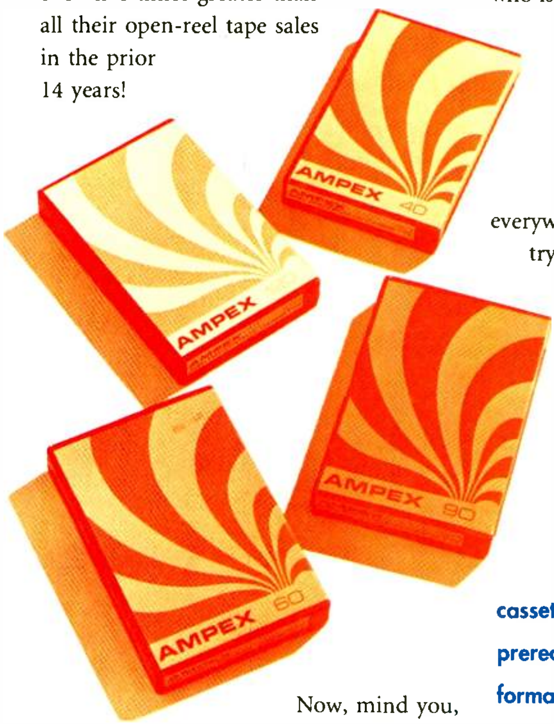
producing 20,000 cartridges per day! As an old open-reel man, I found these figures staggering. RCA stated that their 8-track sales in the prior three years had been five times greater than all their open-reel tape sales in the prior 14 years!



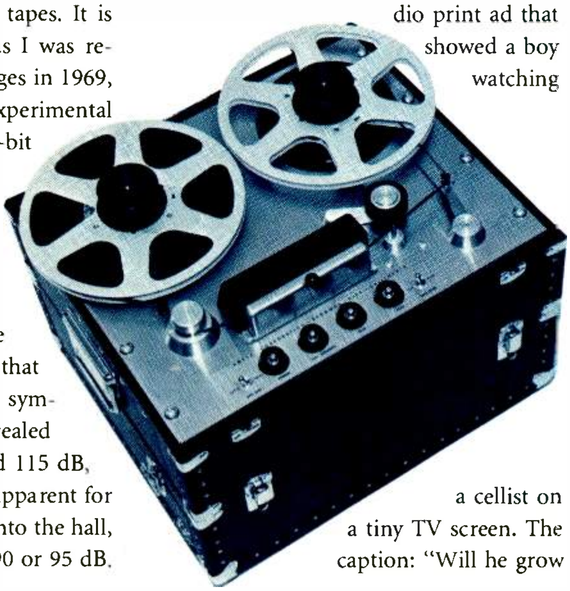
Now, mind you, 8-track tapes at their best had fairly high tape hiss, wow and flutter problems, and mechanical difficulties. But the public accepted these shortcomings in return for a convenient source of recorded music. Some may find a parallel in our present situation of CD versus DCC and MD (although DCC and MD are light-years ahead of the old Stereo Eight cartridges in sonic fidelity). Of course, 8-track cartridges have long since vanished into oblivion, along with open-reel tapes. It is interesting to note that even as I was reporting on Stereo Eight cartridges in 1969, Denon was making their first experimental digital tape recordings on a 13-bit PCM machine in Japan!

In my March 1969 column, I wrote about the growing concern over hearing loss. Prime culprits were loud rock music and environmental noise pollution, though I also noted that measurements I had made at a symphony conductor's podium revealed massive fortes between 105 and 115 dB, a level at which pain becomes apparent for some people. Yet 30 feet back into the hall, the same fortes were down to 90 or 95 dB. Thus came the question, "How loud is too loud?"

The answer is usually a subjective one, based more on what the loud sound is and who is hearing it than on its measured level. There are now legal guidelines for noise exposure in the workplace and for environmental noise pollution. Yet in the years since 1969, environmental noise has worsened considerably. Boomboxes are everywhere—in the big cities, in the countryside, on the beaches. At the famous Jones Beach on Long Island, New York, there are ordinances prohibiting "excessively loud playback" of boomboxes. So we are right back to "How loud is too loud?"

Ampex, riding high in audio, was a leading maker of blank cassettes and open-reel tapes; prerecorded tapes in all formats; home gear, including receivers with four-channel 8-track players, and professional recording gear like the famed 350 open-reel tape transport.

The plight of American symphony orchestras was the subject of my August 1969 column. I recalled a Fisher Radio print ad that showed a boy watching a cellist on a tiny TV screen. The caption: "Will he grow up thinking this is how a cello sounds?" Whether read as a plea for better sound reproduction or as an implicit warning about the dwindling number of orchestras, the ad made a strong impression. "It would appear that throughout our country," I wrote, "many are sounding alarms concerning the institution of the symphony orchestra and, indeed, pondering the status and fate of live music in general."



Unfortunately, 24 years after I wrote that, the financial health of America's orchestras verges on the catastrophic. Many of the smaller orchestras have simply ceased to exist. Others have had their concert seasons reduced dramatically. In the present recessionary climate, fund-raising is an exercise in frustration. Some think a possible answer might be government subsidies, a common practice in Europe, but I'm afraid a lot of people would think these subsidies would have a very low priority indeed.

Note also that back in August

1969, the American Federation of Musicians had established a studio recording rate of $88 per musician for a three-hour session. The current rate is $248.44, which is why so much recording is now done in Europe.

Twenty-five years ago, hi-fi and the audio industry generated a lot of excitement and enthusiasm. It was a time of discoveries and developments in electronics and recording equipment, increased understanding of acoustics, and exploration of new methods and media in the constant striving for ever greater realism in the reproduction of recorded music. Quadraphonic sound was a few years hence, and while it now may be viewed as a debacle, it surely was the progenitor of our present surround sound for home theater.

Currently the audio industry has fallen on perilous times, but it is still a fascinating and wonderful business, and I'm glad to still be a participant in its progress. A

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In recent years Paradigm has become recognized as *the* market leader for performance/value. In fact, Paradigm speakers are consistently rated #1 for price/value in surveys conducted by the trade publication Inside Track. Simply put, Paradigm delivers better sound for less.

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Designing better sounding speakers demands a tremendous commitment to research. This research, however, must be rooted in a firm understanding of how we discern what we hear. Extensive listener preference tests conducted by the National Research Council (NRC) gives Paradigm designers an in-depth understanding of how sound is perceived and clearly establishes what design parameters are most critical to what we hear. To meet or exceed these design parameters in the '90's, however, demands a very large investment in R&D.

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ROAD SIGNS

IVAN BERGER

PROCESSED TO PERFECTION

The trouble with car stereo is that we have to listen to it in a car. This restricts speaker and listener positions, impacts on the acoustics of the listening chamber, and adds an undercurrent of road noise.

Still, I'm optimistic. Cures for all three problems are advancing, albeit at a stately pace. Cars are getting quieter, and reasonably decent speaker positions are being designed into their interiors. And car stereo designers are seeking ways to use digital signal processing (DSP) to further solve these difficulties.

In home systems, DSP has mainly been used to simulate appropriate acoustical spaces for the music being heard. The first car DSP systems tried to do the same thing, but had less success. Somehow, a simulated cathedral or even a concert hall sounds inappropriate in a car; the added reverberation muddies up the sound more than it warms it. I think this may be because these systems tend to play the same sound through the front and rear channels—a dash of ambience in front and rich, rolling reverb from the rear might be a better choice. Nonetheless, these systems enhance my listening pleasure if I keep them at their mildest settings.

But better DSP is here, and more is coming. The DSP circuits built into the Pioneer Premier KEX-M900 (reviewed in December '91) did address one problem, the lack of good front imaging in systems without center speakers. The GTP4, a $199 processor from JBL, promises to create a center image and to offer separate ambience controls for the front and rear of the car. Some crossovers from Sony ES and Alpine include adjustable delays to compensate for some speaker-placement problems.

The SigTech Timefield Acoustic Correction System, not yet available for cars, does ease many room-acoustic problems; Snell and Audio Alchemy are working along these lines, too. Such correctors only work well for listeners in a few, closely grouped seating positions—exactly the situation in a car.

Eventually, DSP will be used to cancel ambient noise, but there are limitations to this approach. "Anti-noise" techniques work best when they're applied at the noise's source, not at the listener's ear. (A noise and an anti-noise from different directions are sometimes heard as two noises.) So, it's easier to apply it to localized sources, like the muffler, than to wind noise and body-panel resonances. Anti-noise could also be fed through speakers near the listeners' ears (possibly in headrests), but even so, there will still be some noise for other DSP systems to work on.

Such systems are already in the works, in the form of dynamic range processors that react to the frequency content and level of both the music and the ambient noise. So far, I've heard an early but impressive prototype of Jensen's Dynamic Signal Optimization system, but I'm sure other companies are working in that general direction.

Will we ever reach the point where people like me write that "The trouble with home stereo is that we don't get to hear it in a car"? Nah. I'm not *that* optimistic.

AMen

AMAX certification attests that a tuner's or receiver's AM section has wide audio bandwidth, NRSC de-emphasis, automatic noise blanking, external antenna connections, full coverage of the AM band's recent expansion, and, if it's stereo, a C-QUAM decoder. The first home tuner to have it, Denon's TU-680NAB SuperRadio, costs $650 (and was reviewed in the April issue). But many of you now have AMAX-certified receivers in your cars.

According to a newsletter from the National Association of Broadcasters, 40% of GM's 1992 cars had AMAX-certified Delco radios. This doesn't surprise me; I had noticed superior AM performance in Delco car units even before AMAX. And my personal benchmark for AM performance remains the AM-only Delco in my family's '54 Pontiac—though I must admit it was helped along by the comparatively clean airwaves of the '50s. A

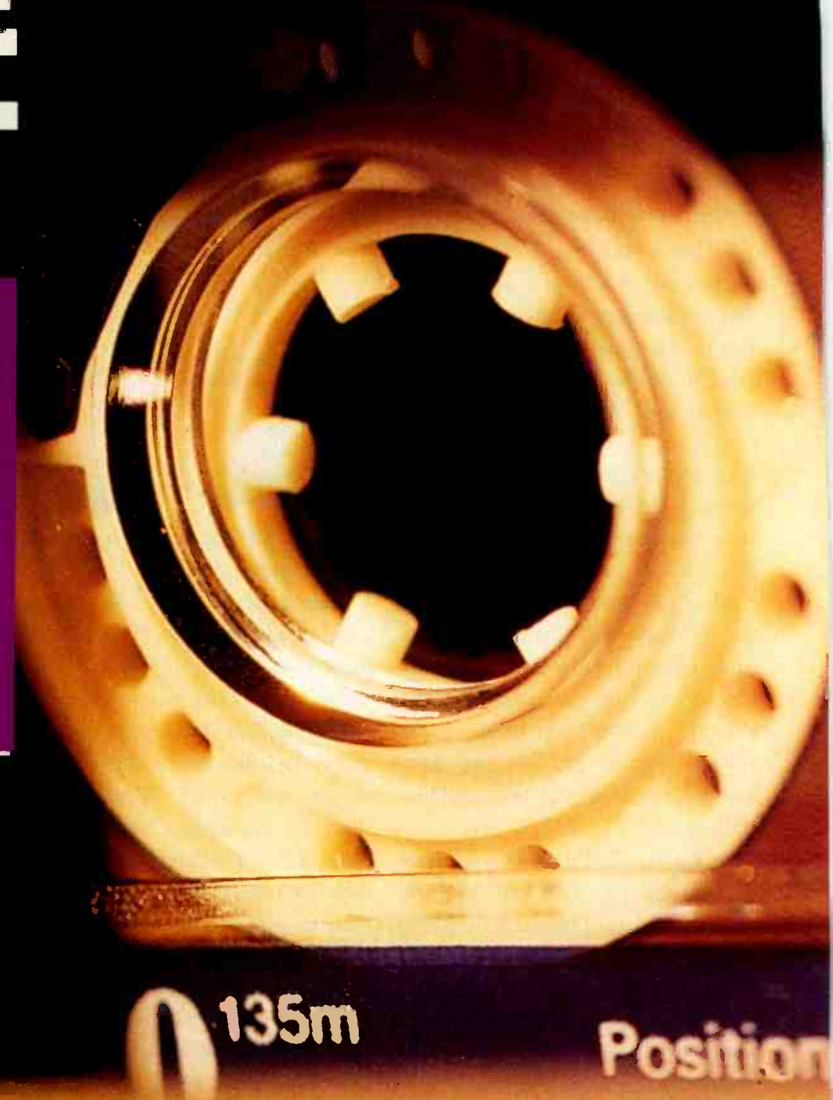
Tomorrow's DSP units will try to make listening in the car more like listening at home, without the car's acoustical and noise problems.

Illustration: Carolyn Fisher

MASS TAPE TEST

51 CASSETTES

EDWARD J. FOSTER



THE SECOND GREATEST CASSETTE TEST EVER

Approximately every three years, *Audio* reevaluates analog cassette tapes. The field isn't static, and it can be difficult to keep up with improvements—major or minor—or even to tell whether any changes have occurred. Some manufacturers mark every slight change in formulation with a spanking new name, but others—especially those with well-recognized brands—do not. Why jeopardize sales of a well-recognized label, they reason, simply because it's been improved? So, even when *names* don't

PHOTOGRAPHS: DAVID HAMSLEY

change, tape *formulations* may; thus, previous data becomes invalid, and it's time to test again.

Until his passing in 1991, my friend Howard Roberson evaluated tape for *Audio.* I had known Howard for years, both through his work in *Audio* and when he served on the Institute of High Fidelity/Electronic Industries Association (IHF/EIA) Tape Recorder Standards Subcommittee, which I chaired. We both were experienced in evaluating tapes and decks, discussed our procedures at some length, and found that we agreed on many points and disagreed on others—as reasonable engineers are wont to do.

Stepping into Howard's shoes this past year has not been easy. I have pretty strong opinions regarding cassette evaluation, yet some consistency in methodology is important to compare yesterday's results with today's. I was encouraged by *Audio*'s Editor-in-Chief, Gene Pitts, to "call 'em as I see 'em" and, within reason, to make whatever

Some makers change tape names for each new formulation, but others use the old names for new tapes.

procedural changes I felt would be beneficial. In making modifications, I was further encouraged by the changes Howard seems to have made in his own explorations over the years, such as shifting from evaluating high-frequency maximum level by the twin-tone method (1987) to the saturation method (1990). More on that later.

Suffice it to say that, though I have made changes which I will outline in detail, I've tried to maintain the spirit of Howard's approach and, in this light, have agreed to rank tapes numerically—a procedure, I will say up front, about which I have strong misgivings. With so much of Howard's past work continuing in this review, I'd like to dedicate this article, with respect and admiration, to Howard A. Roberson.

From 35 tapes reviewed in *Audio*'s November 1987 issue, the number burgeoned to a whopping 88 in March 1990's "Greatest Cassette Test Ever." These included not only well-recognized brands, widely available in stores, but less well-recognized cassettes, some of which could be obtained only by mail. Gene Pitts and I agreed to limit this year's field to "recognized" well-distributed brands. Thus we came up with the "Second Greatest Cassette Test Ever," with 51 cassettes: 14 Type I tapes ("Normal" bias), 23 Type II tapes ("High" bias or "Chrome"), and 14 Type IV tapes ("Metal"). The "Types," by the way, refer to International Electrotechnical Commission (IEC) designations. Brands represented are BASF, Denon, Fuji, JVC, Maxell, Memorex, Realistic Supertape (available at Radio Shack stores), Scotch (made by 3M), Sony, and TDK.

I will dispense with the recitation of manufacturer's claims and the "Star Wars" verbiage used to distinguish one gamma ferric-oxide particle from another. Even if true, statements like these offer little information or content and usually do nothing to tell you what to expect from a tape. I'd rather take the space to tell you *how* each tape was evaluated, including the similarities and differences between my methodology and Howard's, circa 1990, at least as best I can determine what he did.

TEST METHODS

To put everyone on an equal footing, I requested three C-90 cassettes of each formulation from each manufacturer. The thin coating that's frequently used on longer cassettes (and the thick one that may be used on short cassettes) can affect test results—especially vis-à-vis low-frequency maximum operating level (MOL) and S/N ratio—so I wanted all cassettes to be of the same length. Because C-90 remains the overall best seller, again this seemed to be the best length to use.

I intentionally made two exceptions to this rule. Denon S-PORT High, a Type II formulation, and Denon MG-X Metal, the company's top-of-the-line Type IV formulation, are not available as C-90s, so C-100 cassettes were tested in these two cases. Keep in mind that this probably put these tapes at a competitive disadvantage vis-à-vis low-frequency MOL (and maybe in signal-to-noise ratio) but conceivably could have given them a little extra in the

TYPE I MEASURED DATA

Tape	Maximum Output Level, dB, re Dolby Level: MOL 40 Hz	MOL 125 Hz	MOL 400 Hz	MOL 1 kHz	MOL 3.15 kHz	SOL 6.3 kHz	SOL 8 kHz	SOL 10 kHz	SOL 12.5 kHz	S/N Ratio, dBA	−3 dB Response Limit at Dolby Level, kHz	Mod. Noise, dB	Bias, dB	Sens., dB
BASF Ferro Extra I	+0.8	+5.2	+5.7	+6.0	+3.8	+1.8	−0.9	−4.1	−8.0	58.3	9.4	−47.7	+0.4	−0.7
Denon DX-1	−0.4	+4.0	+4.4	+4.6	+0.9	+1.7	−0.9	−3.9	−8.0	57.7	9.5	−49.7	+0.1	−1.2
Fuji DR-I	−0.4	+4.0	+4.6	+4.8	+1.5	+1.6	−0.9	−3.9	−7.8	58.2	9.4	−51.3	0.0	−1.0
JVC GI	−1.5	+3.2	+3.5	+4.1	+1.3	+1.2	−1.3	−4.5	−8.4	56.3	9.1	−47.7	−0.1	−1.0
Maxell UR	−1.7	+2.9	+3.5	+5.5	+3.3	+2.0	−0.8	−3.9	−8.1	56.5	9.5	−52.3	+0.6	−1.3
Maxell XLI	+3.9	+8.2	+8.0	+7.1	+3.6	+2.8	+0.2	−3.4	−8.1	63.6	9.8	−51.7	+0.9	0.0
Memorex dBS	−1.8	+3.6	+4.4	+6.5	+4.7	+2.3	−0.2	−3.8	−8.5	55.7	9.7	−50.4	+0.3	−0.1
Realistic Supertape XR	−0.8	+4.1	+5.0	+6.2	+4.0	+2.1	−0.1	−3.5	−7.6	56.6	9.9	−49.5	+0.2	0.0
Scotch BX	−0.6	+3.7	+4.6	+5.1	+1.6	+1.3	−1.1	−4.4	−8.4	56.5	9.3	−49.3	+0.8	−0.3
Scotch CX	−2.2	+2.3	+2.8	+4.3	+2.2	+1.5	−1.0	−4.5	−8.1	54.5	9.1	−48.0	+1.5	−0.6
Sony HF	+0.1	+4.7	+4.8	+4.9	+1.6	+1.7	−0.9	−4.0	−8.2	58.7	9.5	−50.5	0.0	−1.1
Sony ES-I	+2.4	+6.8	+7.1	+7.1	+4.9	+2.7	−0.1	−3.4	−7.7	62.8	9.9	−52.0	+0.3	−0.2
TDK D	+0.4	+4.9	+5.4	+6.3	+4.6	+1.9	−0.7	−3.9	−8.0	58.6	9.6	−51.9	+0.4	−0.5
TDK DS-X	+2.4	+7.0	+7.3	+7.0	+5.0	+2.3	−0.2	−3.6	−7.8	62.3	9.8	−50.5	0.0	+0.8

Note: Modulation noise values are referenced to Dolby level; bias and sensitivity figures show how far each tape's requirements differ from the IEC Standard for its type.

way of high-frequency saturation operating level (SOL).

Some manufacturers sent more than the three samples requested, but only three (chosen at random) entered the test phase. In accordance with Howard's practice, each tape was opened (following the pull-tab instructions) and then fast-wound and rewound once in each direction. I made notes of how easy it was to open each tape and how noisy it was when fast winding. I don't consider the winding noise of any *great* significance since some relatively "noisy-winding" tapes proved better than average in other, more significant, mechanical aspects (including side-to-side tracking and the like).

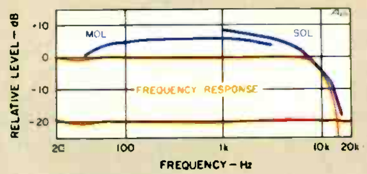
All measurements were made on a Nakamichi 582 deck. Although long in the tooth, this deck remains, in my opinion, *the* most stable platform on which to make in-cassette tape evaluations. The particular deck I use has been preserved *exclusively* for tape evaluation, so, although it's old, it's seen relatively few hours of use and is in pristine condition.

Side A record-head azimuth was aligned for each sample prior to bias and sensitivity determination or any other measurement. Record-head azimuth was matched to the play head through a multistep procedure: Adjust for maximum output at 15 kHz, refine the adjustment to minimize interchannel phase difference at 15 kHz, and, finally, check that the interchannel phase difference decreases monotonically with decreasing frequency. As the second and third samples of each tape were loaded into the deck, I made a note of the interchannel phase error prior to azimuth alignment and noted how much change in alignment was required. This information played a role in concocting the uniformity score.

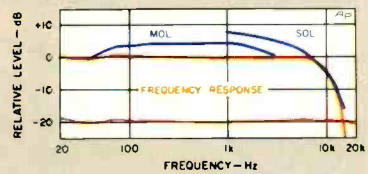
Next, bias was adjusted for equal sensitivity (that is, equal output for identical input) at 400 Hz and 15 kHz at a recording level of 20 nWb/m (–20 dB re Dolby level). This is similar to, but not identical with, Howard's 1990 procedure. Howard adjusted for smoothest response at –20 dB re Dolby level, using pink noise and a third-octave real-time analyzer. I understand his reasoning, but I do not feel that the benefits of adjusting for smooth pink-noise response justify the imprecision inherent in making a pink-noise, third-octave analysis.

TYPE I

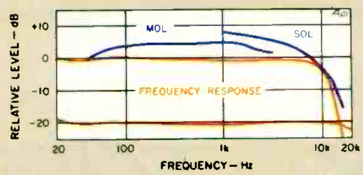
BASF Ferro Extra I



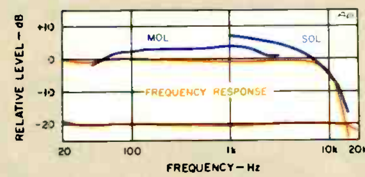
Denon DX-1



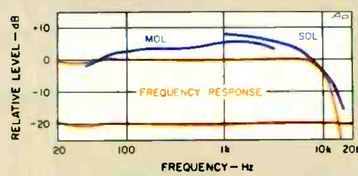
Fuji DR-I



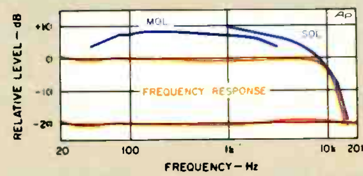
JVC GI



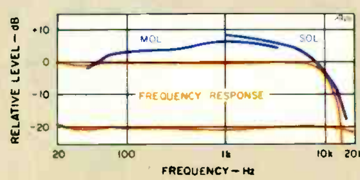
Maxell UR



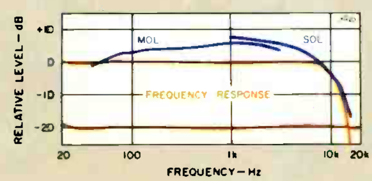
Maxell XLI



Memorex dBS



Realistic Supertape XR



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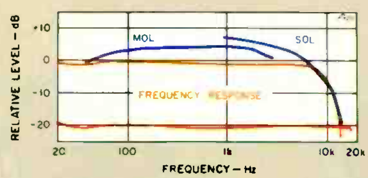
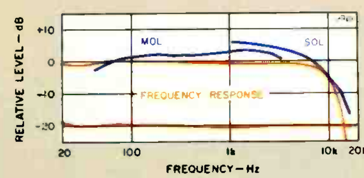
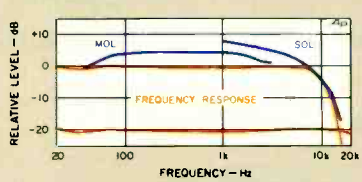


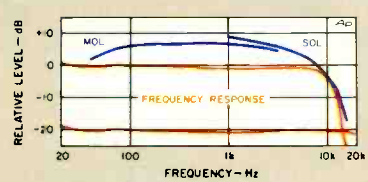
Scotch CX



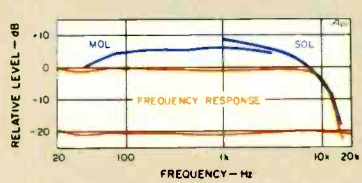
Sony HF



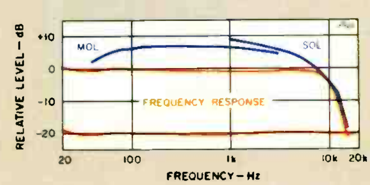
Sony ES-I

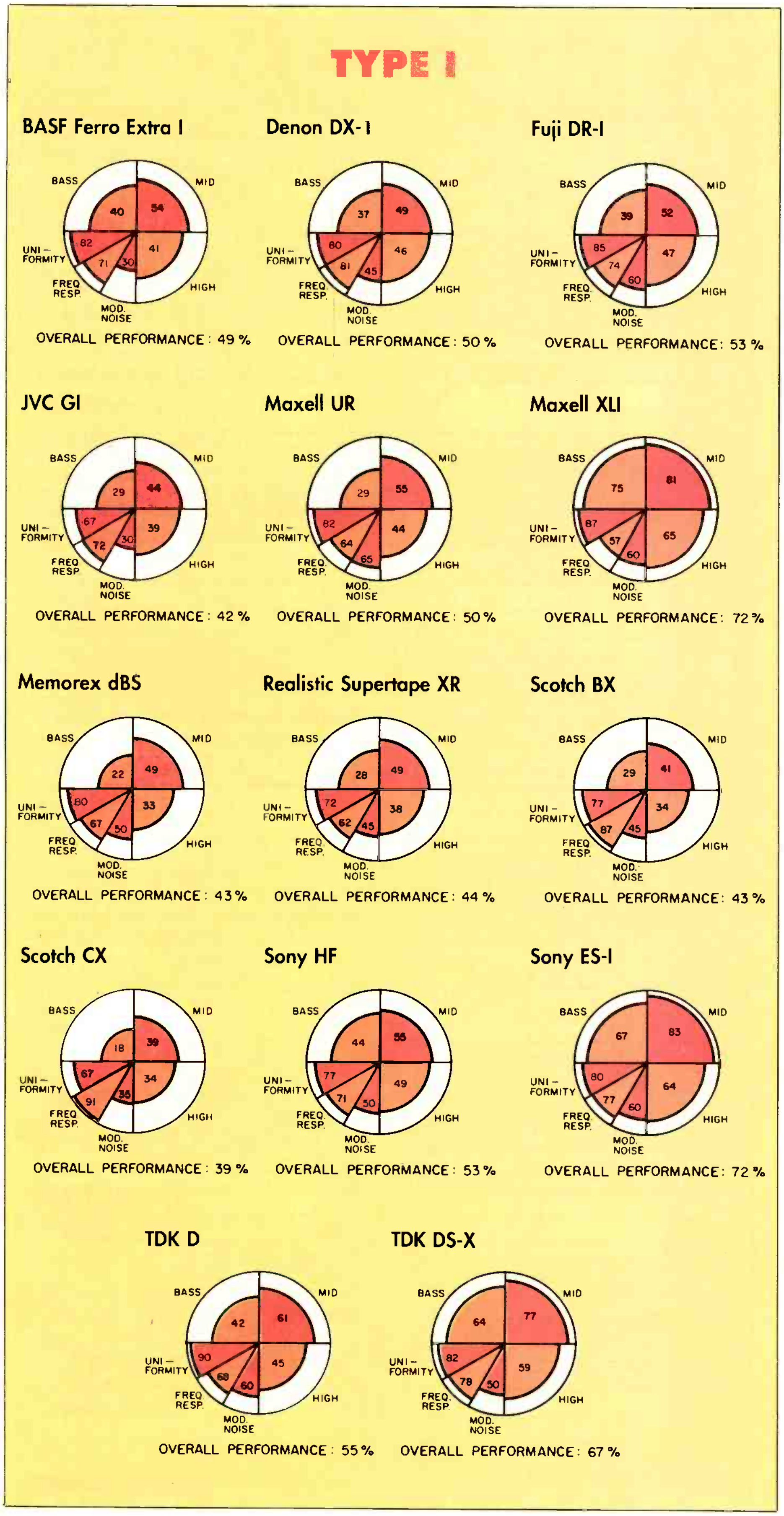


TDK D



TDK DS-X





Other measurements are *strongly* affected by bias setting, so I prefer the precision and repeatability afforded by a two-tone sine-wave adjustment.

After azimuth and bias were adjusted, bias current was measured at the internal monitoring point provided on the Nakamichi 582 for this purpose. The bias for the sample under test was compared with that required to bias the IEC Standard tape for the category (Type I, Type II, or Type IV, as appropriate); the ratio was then expressed in decibels.

In a similar manner, recording sensitivity (the input voltage required to obtain Dolby level) was compared with that required by the corresponding IEC Standard tape, with the ratio expressed in decibels. Bias requirements and recording sensitivity were documented for each of the three samples. I did not determine the bias and sensitivity requirements for the B side of the tape (as Howard did in 1990); I find it inconceivable that they should differ over the tape width, and doing so would have "lost" the A side's azimuth reference that I wanted to maintain to determine side-to-side tracking.

After adjusting azimuth and bias, I plotted record/playback response at 100 points from 20 Hz to 20 kHz, at Dolby level and at 20 dB below Dolby level, using Audio Precision System One test equipment. To obtain the data for the –3 dB response limit listed in the Tables of Measured Data, I repeated the Dolby level measurement over a narrow band of frequencies chosen to determine the –3 dB frequency with greater precision than was possible with a broadband stepped measurement. Response curves for both 0 and –20 dB appear in the graphs this year, for reasons I will go into later. In shifting from the –20 dB level to the 0 dB level, I noted the degree of output compression (or, in a few cases, expansion) at 400 Hz. Although not tabulated, this information entered into my low-frequency rating scheme.

I measured MOL and SOL and plotted them on the same grids as the response curves. The results for MOL (for 3% THD + N) were determined at 20 points, from 40 Hz to 3.15 kHz. This is essentially the same procedure Howard used in 1990, although I increased the number of measurements and went to a higher frequency, for reasons that will become apparent later. Results for SOL were obtained at 13 points from 1 to 16 kHz—the same range but with four more points than Howard used. Again, the reason will become clear later.

Biased-tape noise (that is, the noise level of a tape that has passed over the recording head with bias but no audio signal applied) was measured on an A-weighted basis, using a shorted input and a minimum setting on the record-level control. (I also interposed a high-pass filter to eliminate hum components that might affect the measurement.) Each noise measurement was corrected for the residual noise of the deck. This was done by subtracting the output noise power when playing a "tapeless" cassette from the measured biased-tape noise power and recalculating corrected noise referenced to Dolby level. The A-weighted S/N ratio listed in the Tables is the difference between the tape's MOL at 400 Hz (referenced to Dolby level) and its corrected noise power (also referenced to Dolby level).

I did not measure flutter because, as Howard rightly pointed out in 1990, "The deck has a considerable effect on the exact flutter—for any tape." So much so, in my opinion, that flutter measured on one deck cannot be relied on as a means of evaluating the cassette shell. To get a handle on shell characteristics, I used a 10-kHz tone to measure interchannel phase error for one minute on side A. The max/min phase error was determined and entered into the uniformity score. At the conclusion of all tests, I flipped the tape over and made an interchannel phase measurement on side B, *without* adjusting azimuth, using a 3.15-kHz tone. This suggested how well each tape tracked within its cassette, and performance in this regard was a factor in the uniformity score. Also destined to factor into the score was uniformity of output level at three frequencies: 400 Hz, 3.15 kHz, and 10 kHz.

Finally, I measured modulation noise following the procedure that Howard pioneered: Record a high-level 1-kHz tone, bandpass-filter the output from 500 to 1,500 Hz (to eliminate distortion components and reduce "conventional" noise), and then use a distortion analyzer to notch the 1-kHz tone and measure the residual noise in dB below the tone level. Essentially this methodology totals the energy that exists in any AM and FM sidebands that may have been generated within ±500 Hz of the tone by modulation noise. The average of the maximum and minimum readings over a 20-S period is tabulated, but I must warn you that the "spread" in readings on most tapes is wide (averaging about ±1.5 dB), so small differences in tabulated data are meaningless.

51 CASSETTES

The use of 120-μS EQ raises Type I tapes' noise levels, reducing their overall scores.

USE TESTS

Except for the Denon products, Maxell's UR, and TDK's D and DS-X, most of the cassettes were easily unwrapped, and I may have been fumble-fingered with the aforementioned. Memorex and Radio Shack (Realistic Supertape) wrappers were particularly easy to open, since their pull tabs are slightly extended and you needn't scratch them free with your fingernail. Some tapes did not have pull tabs, but that didn't seem to affect my ability to open them. In any event, most shrink-wraps open easiest if you pull diagonally (not straight across) from the point indicated and in the direction of the arrow (if there is one). Some are quite perverse in that they seem to open "backwards"; always stick with the arrow if there is one.

Rounded-edge cassette cases are "in" this year. Except for their least expensive Type I cassettes, Denon, Maxell, Memorex, Sony, and TDK tapes all use these new smooth cases. Fuji goes a step further in innovative design. Its Extraslim case is designed to hold the cassette wrong way 'round, that is, with the head-opening portion exposed when you open the case. The Fuji Extraslim case is rounded and only 0.55 inch thick—about ⅛ inch slimmer than normal. It's great when taking a pocketful of cassettes on a jog or on the road, but the case rattles around in fixed-width cassette racks, and Fuji is forced to fold the insert card (J-card) to keep it out of the way of the cassette. Denon S-PORT's case also is thinner than normal (just slightly thicker than Fuji's), but it holds the cassette in normal fashion and uses a normal J-card. Perhaps the most high-tech-looking case is the all-black box used for Fuji ZII.

Realistic Supertape cases are flimsier than others. Memorex dBS also has a lightweight case; the premium Memorex products are notably better. Most products come with pressure-sensitive cassette labels, the only exceptions being JVC GI and the Realistic Supertape line. I won't characterize every label and insert card in detail but will provide a thumbnail sketch in each tape's write-up. Suffice it to say that, unfortunately, some labels are too small to write on, others have a treated surface you can't write on with a ballpoint pen, and some insert cards are dolled up with a lot of high-tech-looking doodads that get in the way of the card's purpose.

With one exception (TDK MA-XG), all of the cassette shells were fabricated in two halves and held together by five screws located in the conventional places, one in each corner and one just behind the head opening. The MA-XG's Reference Standard Cassette Mechanism III is assembled from five pieces—two faceplates and three side frames—that are held together by four screws that enter from the edges, rather than from the top of the cassette, and a fifth screw in the conventional location just behind the head opening. TDK claims advantages in vibration reduction from using this design.

Among the pricier tapes, the move is toward anti-resonance cassette shells that are meant to reduce modulation noise by pre-

Type II Measured Data

Tape	Maximum Output Level, dB, re Dolby Level: MOL 40 Hz	MOL 125 Hz	MOL 400 Hz	MOL 1 kHz	MOL 3.15 kHz	SOL 6.3 kHz	SOL 8 kHz	SOL 10 kHz	SOL 12.5 kHz	S/N Ratio, dBA	−3 dB Response Limit at Dolby Level, kHz	Mod. Noise, dB	Bias, dB	Sens., dB
BASF Chrome Extra II	−0.5	+4.5	+4.7	+3.7	−1.4	−1.3	−3.5	−6.4	−11.2	64.4	7.8	−47.7	+0.6	+0.6
BASF Chrome Super II	+0.4	+5.7	+5.5	+3.8	−1.9	−1.3	−3.5	−5.8	−10.3	64.8	7.5	−49.2	+1.4	+1.5
BASF Chrome Maxima II	0.0	+5.3	+5.2	+3.5	−2.1	−1.7	−3.5	−6.4	−10.5	65.0	7.2	−48.4	+1.3	+1.4
Denon S-PORT High	−1.3	+3.7	+4.1	+4.3	−0.6	+0.5	−1.7	−5.2	−9.5	61.0	8.9	−49.5	+0.9	+1.4
Denon HD6	−1.0	+4.2	+4.5	+4.3	−0.6	+0.4	−2.0	−4.9	−9.6	61.5	8.8	−47.9	+0.6	+1.5
Denon HD7	−1.7	+3.8	+4.2	+4.2	+0.2	+1.1	−0.9	−3.7	−7.6	61.7	9.6	−50.6	+1.4	+1.3
Denon HD8	−0.3	+5.0	+5.4	+5.7	+2.6	+3.1	−1.4	−1.0	−3.7	59.6	11.5	−49.2	+0.8	+3.4
Fuji DR-II	−2.0	+3.4	+4.1	+4.7	−0.9	−0.5	−2.5	−5.4	−8.7	64.1	8.2	−51.0	+0.9	+2.3
Fuji FR-IIx	−0.5	+4.4	+4.9	+5.1	−1.0	−0.5	−2.6	−5.4	−9.0	64.8	8.2	−51.6	+0.7	+2.6
Fuji FR-IIx Pro	+0.9	+5.7	+6.2	+5.3	−1.2	−0.1	−2.4	−4.9	−8.8	66.2	8.6	−51.8	+1.0	+2.6
Fuji ZII	+1.0	+6.0	+6.3	+5.0	−0.9	+0.3	−1.8	−4.4	−8.0	66.7	9.1	−51.5	+1.7	+2.0
JVC AFII	−1.2	+3.9	+4.3	+4.4	−0.1	+1.4	−0.8	−3.8	−7.8	59.0	9.6	−52.5	+1.6	+1.1
Maxell XLII	+1.5	+6.5	+6.8	+6.3	−0.2	+1.3	−1.0	−4.4	−9.8	65.3	9.4	−53.3	+1.5	+1.9
Maxell XLII-S	+1.3	+6.2	+6.5	+6.4	−0.1	+1.7	−0.7	−3.7	−8.5	64.0	9.7	−57.0	+1.6	+1.7
Memorex HBSII	+0.4	+5.8	+5.9	+5.7	0.0	+1.4	−1.5	−4.6	−8.3	62.2	9.6	−50.3	+0.9	+1.5
Realistic Supertape HD	−1.7	+3.5	+3.9	+4.6	−0.2	+0.8	−1.5	−4.6	−8.3	60.8	9.1	−50.9	+1.0	+1.2
Realistic Supertape Premium MII	−0.3	+5.3	+6.1	+6.2	+2.4	+3.4	+1.7	−0.4	−3.1	60.2	12.4	−51.0	+1.7	+3.4
Scotch XSII-S	+0.1	+5.3	+5.7	+5.8	+0.3	+1.3	−1.0	−4.1	−8.4	62.1	9.4	−50.7	+0.7	+1.7
Sony UX	−0.1	+4.9	+5.4	+5.1	−1.0	+0.8	−1.4	−4.6	−9.3	65.2	9.1	−50.9	+1.4	+1.4
Sony UX-Pro	+1.0	+6.1	+6.5	+6.1	+1.3	+1.7	−0.5	−3.7	−7.8	64.4	9.6	−53.5	+1.4	+1.8
TDK SD	−1.0	+3.6	+4.1	+3.9	+0.2	+0.6	−1.9	−4.6	−8.6	63.9	9.1	−48.8	+0.6	+1.9
TDK SA	+0.9	+5.8	+6.1	+5.9	+0.9	+1.6	−0.8	−3.8	−8.3	64.4	9.7	−52.3	+1.2	+2.3
TDK SA-X	+1.1	+6.0	+6.8	+6.4	+0.4	+1.1	−0.8	−3.6	−7.4	65.2	9.8	−53.5	+1.3	+3.1

Note: Modulation noise values are referenced to Dolby level; bias and sensitivity figures show how far each tape's requirements differ from the IEC Standard for its type.

venting vibration of the housing (and, indirectly, the tape). TDK's MA-XG shell is one approach. More typical are the trends toward using resins that are loaded with fillers to increase mass and/or the internal losses of the plastic (the MA-XG shell is made of Fiberglas-reinforced plastic), using laminated shells (multiple layers designed to damp one another), and using smaller cassette windows. The thought here is that the thin transparent window impairs housing rigidity and damping—so the smaller, the better.

Sony Metal Master, for example, uses a ceramic composite shell and tape guides and has a very tiny window. (Metal Master also shares another structural idea with TDK MA-XG: Both cassettes' shells have replaceable anti-erasure tabs, a nice feature for those who rerecord.) Denon's MG-X uses a "high specific-gravity half," while Maxell Metal Vertex has a pair of solid brass plates (one of which carries a serial number) laminated to the center of the housing. Does it work? Well, Metal Vertex had the lowest measured modulation noise by a *significant* amount. Can't say that that's entirely due to the housing, but it probably didn't hurt!

Although many cassettes have tactile clues to identify sides A and B, they vary widely in usefulness. Some of these clues will be covered when an ID label is applied; I found others too mysterious to identify by touch. Fuji, commended by Howard in 1990 for including Braille markings, has dropped tactile markings entirely. Maxell, whose markings I particularly liked on its lesser products, omits them on Metal Vertex (presumably because they might interfere with shell performance). The same goes for TDK MA-XG and Sony Metal Master. I'm afraid you'll have to check this out on a case-by-case basis.

Although most tapes got a bit noisy when winding at high speed near the end of a side, the noisiest were the three Memorex products (dBS, HBSII, and CDX IV Metal), Fuji DR-I, JVC AFII, and Realistic Supertape MIV. Exceptionally quiet-winding tapes were Maxell's XLI and XLII-S, Sony's ES-I, and TDK's SA, SA-X, MA, and MA-XG. Except for one of the Sony Metal SR cassettes, which jammed and was dropped from the tests, all samples ran smoothly at normal speed and completed the test sequence. Sony Metal SR electrical data is therefore based on two samples.

MEASUREMENTS

Many of the measurements made on these 51 products do not appear directly in this report; some were used just to rate the tapes for uniformity and appear only indirectly in the pie charts. The data that *does* appear is in tabular and/or graphical form. Because much of the data is given in decibels, at this point I want to digress and discuss reference levels and frequencies.

The reference conditions used for this test series—the so-called Dolby level of 200 nWb/m, at a frequency of 400 Hz—are those Howard used in 1987 and 1990. (I'll repeat his admonition that "although there are references to Dolby level, no tests were run with any sort of noise reduction.") While I followed Howard's reference frequency and level, I would point out that there is an internationally accepted *IEC* Standard (sometimes called the DIN Standard), which references a recording level of *250* nWb/m at *315* Hz. My druthers would have been to go with the IEC Standard, as I have in the past; I followed the Dolby level references only to be consistent with Howard's past practice. You can translate to the IEC reference (with reasonable, if not exact, accuracy) by subtracting 1.9 dB from each figure for MOL, SOL, and modulation noise given in the Tables. (Do not convert S/N, since this is a *ratio.*)

As stated earlier, I made response measurements at two levels (0 and –20 dB), and both curves are shown in the graph for each tape. There are several reasons why. Some tape formulations have very flat response at –20 dB with standard equalization. I consider this an advantage and took it into account in my ratings. Others—typically, but not necessarily, multilayer tapes—may exhibit a midrange dip followed by a treble boost and often a roll-off above 15 kHz. These tapes may have other strengths, but uniform response with standard equalization is not one of them, and you should be aware of this fact. You can see the swayback shape in the –20 dB response curves.

Furthermore, a tape with a treble rise in the –20 dB response gets a head start, so to speak, on attaining a seemingly impressive high-level high-frequency response. On such a tape, the –3 dB response limit may occur at a higher frequency than that of a competitive tape *even though the recording may be compressed and distorted.* For this reason, I have not included the response limit in my ranking system or in the pie charts, even though it played a major role

Because of 70-μS playback EQ, Type II tapes are usually quieter than Type I formulations.

in Howard's evaluation. The results are included in the Tables *only* to be consistent with past reports. In evaluating the –3 dB point data, I suggest you compare the shapes of the response curves at –20 and 0 dB. If the curves are parallel over most of the range, the –3 dB figure may be meaningful. But if the 0-dB curve sags in the high-frequency range, the recording is being compressed even at frequencies well below the –3 dB point. This is my rationale for including both response curves.

Next let's discuss MOL and SOL and the differences this year from 1987 and 1990. As you may be aware, above some frequency you cannot validly determine the maximum recorded level characteristics of a tape on the basis of an harmonic distortion measurement (so-called MOL). This is because the playback head cannot resolve the third (predominant) harmonic and therefore yields a distortion figure lower than is proper, leading to inaccurately high apparent MOLs. Instead, methodologies based on output compression, twin-tone intermodulation distortion, or tape "saturation" must be employed. This raises the questions of what high-frequency methodologies should be used and above what frequency the methodologies should change.

Based on research I did in the 1970s for a paper I presented at an Audio Engineering Society Convention, there is no question in my mind that the twin-tone IM method yields the most meaningful and valid results *provided that you take all third-order cross-products into account.* I was able to show that measurements of maximum recorded level using this technique yield virtually identical data to traditional 3% HD_3 MOL evaluations in the low-frequency region and a smooth transition from there to the high-frequency region. The problem with the twin-tone method (which I had used in the past and which Howard used in one form or another in 1987) is that it is devilishly time-consuming.

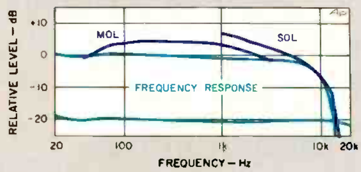
Of the other two methods—compression and SOL—the former arguably is the more meaningful and can be correlated directly with distortion, but it is difficult to make with precision because high-frequency level inconsistency can mask the compression. That leaves us with SOL—simply determining the maximum output level that can be achieved regardless of compression (which will be severe at that point) or distortion (which also will be severe). This is the *practical* method, the one Howard used in 1990, the one that just about everyone uses, and the one I used this year.

This brings us to the frequency at which one should switch from MOL (the maximum recorded level for 3% THD + N) to SOL (recorded level for tape saturation). In 1990, Howard made the switch at 1 kHz. I think it should be higher because MOL is a "better" measurement and because, considering the quality of tapes we are testing and the resolution provided by the Nakamichi 582, I believe valid MOL measurements can be attained to *at least* 3.15 kHz. (When MOL data becomes invalid, it's apparent because the curve no longer slopes downward with increasing frequency but instead flattens out and ultimately may even rise.)

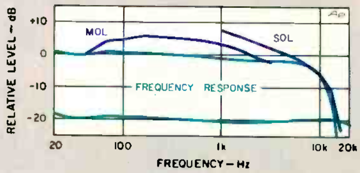
For these tests, I measured MOL at 20 points, one every third octave from 40 Hz to 3.15 kHz. I dropped the lowest octave (20 to 40 Hz) that Howard documented because "head bumps" (the fringing effect of the playback head) affect validity in this region. I extended the upper frequency range by $1\frac{2}{3}$ octaves (from 1 to 3.15 kHz) to document MOL to as high a frequency

TYPE II

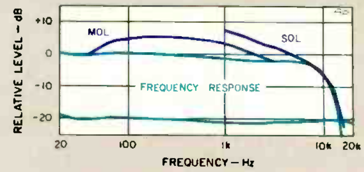
BASF Chrome Extra II



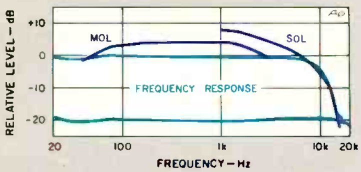
BASF Chrome Super II



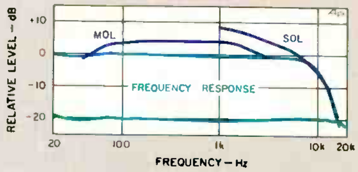
BASF Chrome Maxima II



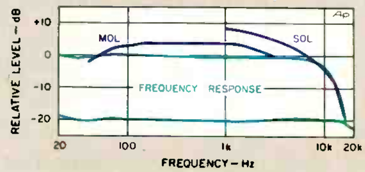
Denon S-PORT High



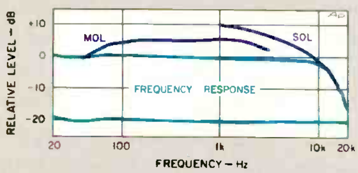
Denon HD6



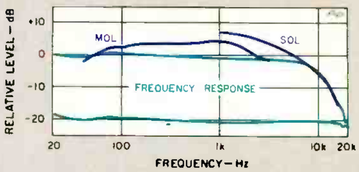
Denon HD7



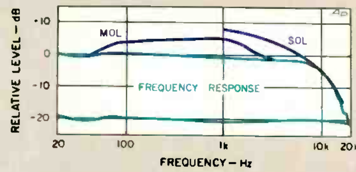
Denon HD8



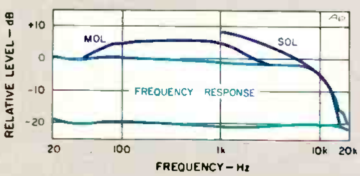
Fuji DR-II



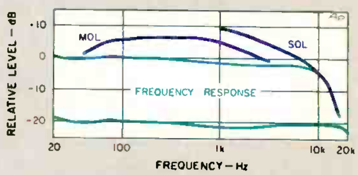
Fuji FR-IIx



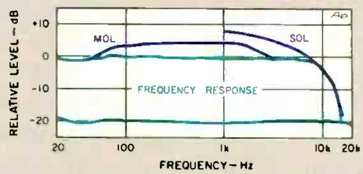
Fuji FR-IIx Pro



Fuji ZII



JVC AFII



as possible, and I increased the number of measurement points from 11 to 20.

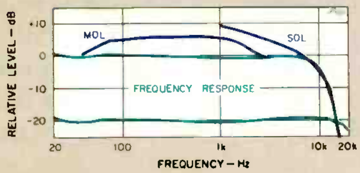
In the Tables, you'll find MOL listed at five of those 20 frequencies. (Of course, all 20 were used for the graphs and in my rating system.) I tabulated data at five, rather than three, frequencies so you can make your own comparisons more precisely than is possible from the small graphs. In the Tables, I switched to the saturation (SOL) methodology above 3.15 kHz and listed data at four frequencies rather than the three used in 1990. For comparison to Howard's data, I measured SOL at 13 points, in third-octave intervals, from 1 to 16 kHz. The full range of MOL and SOL data is plotted in one color in the graphs; the frequency response curves appear in another color. You can identify MOL data by the range over which it extends (40 Hz to 3.15 kHz) and SOL data by its range (1 to 16 kHz). In the overlap region (1 to 3.15 kHz), I advise you to go by the MOL data rather than the SOL data; the former is more conservative.

The remaining columns in the Tables are the same as Howard used in 1990. As previously described, S/N ratio is defined as the difference between the 400-Hz MOL and the corrected A-weighted biased-tape noise. (To derive the A-weighted noise level, subtract the S/N figure from the 400-Hz MOL. You should end up with a *negative* number that is *numerically* smaller than the S/N ratio.) Next comes the data for –3 dB response limit, that is, the frequency at which response has fallen by 3 dB relative to 400-Hz response at Dolby level. (As mentioned, I'd take these results with a grain of salt.) When you look at the results for modulation noise, remember that small differences among them are meaningless; each figure has a range of about ±1.5 dB. The data for bias and sensitivity requirements relative to the IEC Standard tapes are averages of the results for the three samples of each formulation.

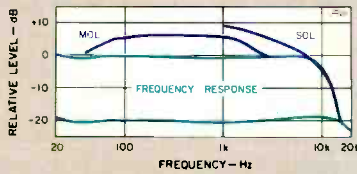
Although my Tables of Measured Data give essentially the same information as did Howard's in 1990 (albeit with a few extra MOL and SOL points), and so serve as a link to the past, my pie charts are quite different from his. You will not find 0-dB response or S/N in my pie—at least not per se—and my uniformity segment includes many of the parameters Howard placed in his smoothness segment. And, I have included modulation noise and frequency response (taken at –20 dB) as separate segments.

TYPE II

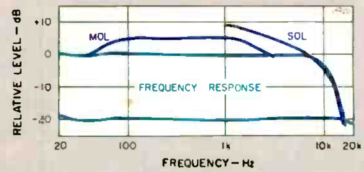
Maxell XLII



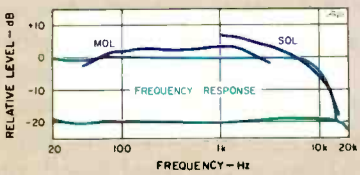
Maxell XLII-S



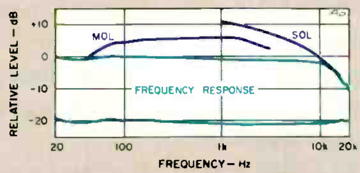
Memorex HBSII



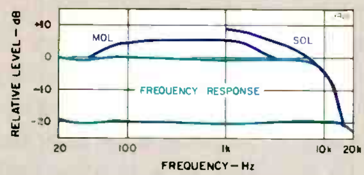
Realistic Supertape HD



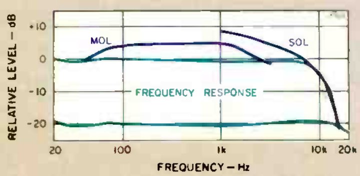
Realistic Supertape MII



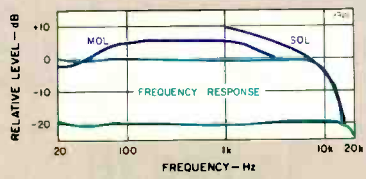
Scotch XSII-S



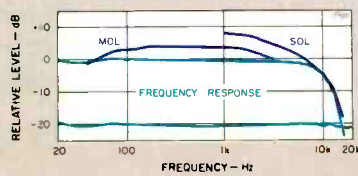
Sony UX



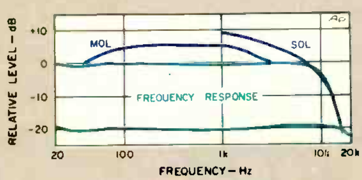
Sony UX-Pro



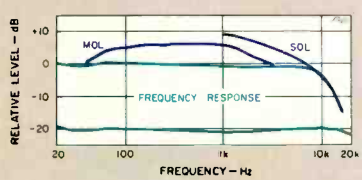
TDK SD



TDK SA



TDK SA-X



I really struggled with [the Editor about] assigning ratings, because as I said early on, I'm philosophically opposed to using them. It's too easy for too many people to read too much importance into a difference of a few rating points. I can assure you that, had I chosen a different (but nonetheless reasonable) rating scheme, I could have come up with quite different scores and different winners. I'm not saying that the lowest rated tape would jump to the top of the heap, but I am sure that tapes within a few ratings points of each other could have come out in different order.

I decided to place major emphasis on what might be called available dynamic range in three regions of the spectrum: From 40 to 400 Hz (which I call the bass and low fundamentals), from 1 to 6.3 kHz (midrange and upper fundamentals), and from 8 to 12.5 kHz (high treble). For each region, I rated each tape in accordance with its MOL and/or SOL performance, *averaged across the region.* This was done to avoid giving an artificially low or high rating to a tape that happened to do particularly poorly or well at, say, 400 Hz (the basis for Howard's low-frequency MOL segment) or 4 kHz (the basis for his high-frequency SOL segment) but did better or less well a half octave or so away.

I then further weighted each rating in accordance with the corrected A-weighted noise data and, finally, scaled the ratings so that the highest score in each region (among all the formulations tested, that is, not segregated by tape type) would be 100%. Thus, *each* of my segments is, in a sense, a relative S/N rating, with the "signal" being the maximum capability of the tape in that frequency region. The figure within the pie segment is the relative score in percent, *not* raw data.

I combined the noise and MOL/SOL data in each band to avoid overrating a tape that happened to have particularly high 400-Hz MOL but marginally higher than average noise. With the old rating scheme, such a tape could have been very highly rated in low-frequency MOL *and,* provided the noise wasn't all *that* bad, well rated in S/N—thereby getting good ratings over 135° of the pie while (possibly) being substantially worse than average in high-frequency SOL and getting "marked down" over only 60° of the pie.

"Double-dipping" was also possible in high-frequency SOL and 0-dB response. A tape with good treble SOL is likely to have good 0-dB response and therefore "double-dip" on the positive side. (Obviously, the reverse is true for a tape with poor treble SOL.) Furthermore, I really had a problem giving emphasis to the 0-dB response figure, for the reasons stated earlier.

I decided to give three-quarters of the pie to the three segments for available dynamic range (90° each) and divide the remaining 90° equally among three other factors: Modulation noise, frequency response, and uniformity. Because the data is imprecise (as described previously), modulation noise was rated in discrete increments that, after scaling, ranged from 30% to 100%. Frequency response was rated in accordance with the maximum total deviation from flat response in the range from 400 Hz to 15 kHz, at 20 dB below Dolby level. This rating also was scaled to give the "best" tape of the group 100%.

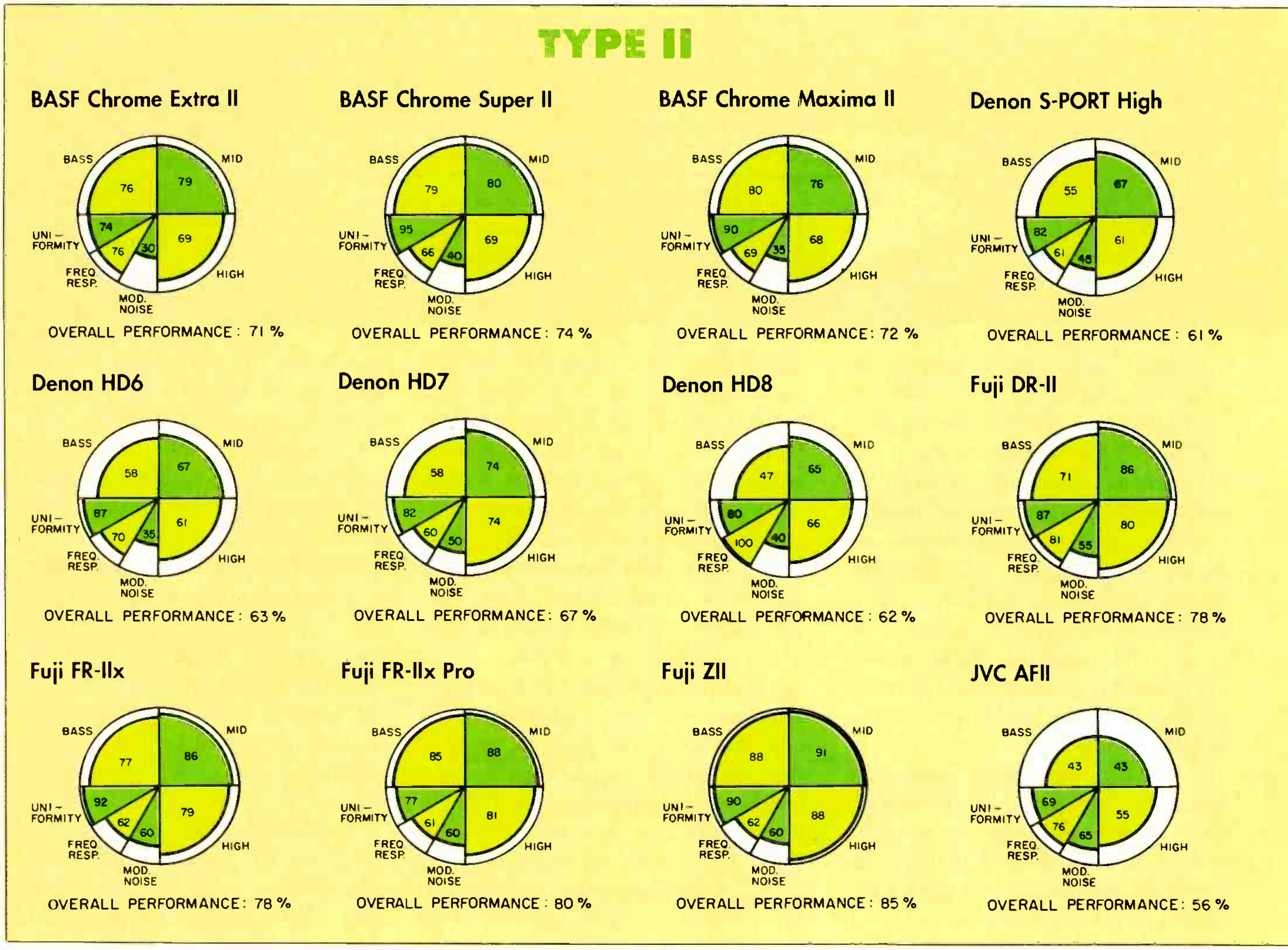
The uniformity segment includes many factors: 400-Hz, 3.15-kHz, and 10-kHz level uniformity; how closely average sensitivity and average bias requirement adhered to the norms; how closely the three samples agreed in sensitivity, bias requirement, and azimuth alignment; tracking of side A, and tracking from side A to side B. All factors did not receive equal weighting, and I did not scale the data. Therefore, you'll not find any tape with a score of 100%.

The numbers within each segment of the pie represent relative ratings in that category, not raw data. You'll find some of the latter (albeit not all of the data that was taken) in the Tables. The overall performance rating (in percent) was calculated by weighting each of the individual ratings in accordance with the area of the pie segment corresponding to it.

The following brief comments on each tape are arranged alphabetically, by brand, within each tape type. Be aware that the rating system is *independent* of type—that is, Type I tapes are competing directly with Type IV formulations—and the ratings are independent of price. Also be advised that one result of including noise over three-quarters of the pie was to decrease the average score of Type I tapes vis-à-vis Howard's ranking system. You may wish to rescore within tape types. References to "noise," below, relate to actual noise power rather than to the A-weighted S/N in the Tables (which is referenced to MOL at 400 Hz).

TYPE I TAPES

It's not unusual to find Type I tapes that have higher MOLs and SOLs than many Type II cassettes. But they're no match for the Type IV tapes (as a group), and, because they use 120-μS equalization, A-weighted noise level typically is higher on Type I than on Type II and Type IV tapes, thereby reducing their overall rating. The average score for the group of 14 Type I tapes is 52%, with individual scores ranging from a minimum of 39% to a maximum of 72%.



BASF Ferro Extra I: Good MOL to 1 kHz and decent SOL. Better high-frequency level stability and lower modulation noise would help performance. Tape tracks well. Good J-card, small label. Overall rating: 49%.

Denon DX-1: Good SOL for a Type I, but MOL could be better. Flat response, good tracking, and good level stability to 3.15 kHz. The 10-kHz stability could be better. Cluttered J-card. Overall rating: 50%.

Fuji DR-I: Lower than average modulation noise for a Type I and good SOL. MOL could be better. Level uniformity better than average at all frequencies. Average tracking. Sparse J-card. Extra-slim case. Overall rating: 53%.

JVC GI: Below average MOL and SOL and relatively high modulation noise and A-weighted noise. Worse than average level stability. Skimpy J-card. Permanent label. Not a lot to recommend it. Overall rating: 42%.

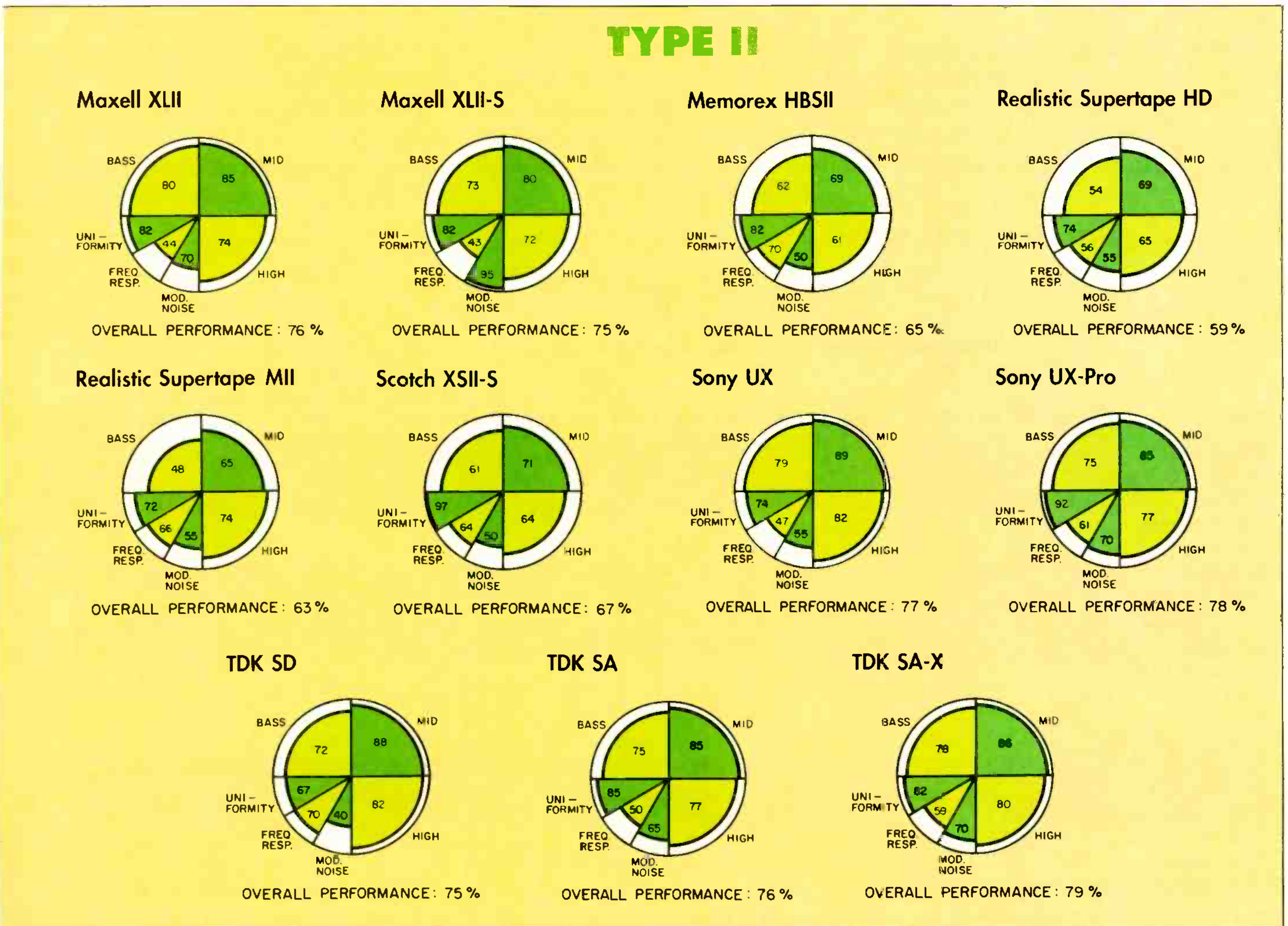
I placed major emphasis on available dynamic range in the bass, midrange, and treble.

Maxell UR: Below average bass MOL up to 400 Hz but improves thereafter. Decent SOL. Lowest modulation noise in Type I. Excellent tracking and level stability. Rudimentary J-card. Overall rating: 50%.

Maxell XLI: Best Type I MOL at 400 Hz and below. Drifts down toward 3.15 kHz. Low A-weighted and modulation noise. Excellent tracking. Response curve more swayback than most. Good packaging. Overall rating: 72%.

Memorex dBS: Relatively poor MOL at 400 Hz and below. Improves strongly at higher frequencies. Good SOL. Worse than average 400-Hz uniformity. Okay at other frequencies. Relatively noisy. Rudimentary J-card. Overall rating: 43%.

Realistic Supertape XR: High noise but decent MOL and excellent SOL. Swayback response and below average level uniformity at all frequencies. Rudimentary J-card, fixed labels. Overall rating: 44%.



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Although you pay a premium for Type IV tapes, as a group they outperform the others.

Scotch BX: Relatively low MOL and SOL but reasonably well balanced. Smooth frequency response, decent tracking, and better than average level uniformity. Noise level could be lower. Good labels. Overall rating: 43%.

Scotch CX: Very poor MOLs and SOLs plus relatively high noise, deviant bias requirement, and average level uniformity; little to recommend except flat response. Good labelling. Okay packaging. Overall rating: 39%.

Sony HF: Average MOLs and SOLs but relatively quiet for a Type I. Well-balanced performance and good ratings. Midrange uniformity worse than average. Choice of labels, adequate J-card. Overall rating: 53%.

Sony ES-I: Excellent MOLs and SOLs for Type I. Very quiet. Low modulation noise and flat response. Tape tracks well. Uniformity better than average at 400 Hz, average elsewhere. Good labelling and packaging. Overall rating: 72%.

TDK D: MOLs and SOLs approach premium Type I performance. Low modulation noise and relatively quiet. Level uniformity average to better than average. Good tracking. J-card and labelling okay. Overall rating: 55%.

TDK DS-X: Excellent MOL and SOL, especially at 3.15 kHz. Quiet, with low modulation noise. Perfect side A/B tracking. Excellent 400-Hz uniformity. Elsewhere, average uniformity. Nice J-card and labelling. Overall rating: 67%.

TYPE II TAPES

Thanks to 70-µS playback equalization, Type II tapes are usually quieter than Type I tapes. But with standard Type II tape, 70-µS *playback* equalization requires a substantial high-frequency boost in the *recording* equalizer. The effect this has on SOL varies with the magnetic pigment used to make the tape.

The SOL of typical Type II tapes formulated with cobalt-modified gamma ferric-oxide particles often is less than the SOL of a premium Type I. MOL can be slightly lower as well. Type II tapes formulated from chromium-dioxide particles generally have even lower SOLs than those made from cobalt-modified gamma ferric oxide, but they tend to be quieter too.

Type II tape also can be made using a metal-particle formulation. Such tapes have extraordinarily high SOLs—higher than any Type I and even than most Type IVs—but they tend to be noisy and have very high sensitivity. When used on a deck without record-level calibration facilities, Dolby tracking can be affected, with notable impairment in audible response.

Since I took noise into account in *all* bands in my pie charts and rating system, all Type II tapes are put on an equal footing in the treble region; therefore, those with

Type IV Measured Data

Tape	Maximum Output Level, dB, re Dolby Level: MOL					SOL				S/N Ratio, dBA	−3 dB Response Limit at Dolby Level, kHz	Mod. Noise, dB	Bias, dB	Sens., dB
	40 Hz	125 Hz	400 Hz	1 kHz	3.15 kHz	6.3 kHz	8 kHz	10 kHz	12.5 kHz					
Denon HDM	−0.4	+5.5	+5.8	+5.9	+1.4	+3.0	+1.1	−1.3	−4.6	63.6	11.4	−52.3	+1.1	−0.5
Denon MG-X Metal	+0.1	+5.6	+6.5	+6.7	+1.4	+3.2	+1.2	−1.6	−4.7	64.2	11.7	−52.6	+1.2	−1.0
Fuji FR Metal	+3.4	+8.8	+9.4	+9.7	+3.8	+5.0	+2.9	−0.3	−3.8	65.4	12.2	−51.6	+1.9	+0.6
JVC XFIV	+1.1	+6.9	+7.9	+8.9	+3.1	+4.5	+2.3	−0.6	−5.0	65.0	12.1	−53.8	+2.2	+0.2
Maxell MX	+2.4	+8.0	+8.4	+8.6	+3.1	+4.5	+2.2	−0.7	−4.5	66.1	11.9	−51.9	+1.5	+0.4
Maxell MX-S	+1.2	+6.8	+7.5	+8.3	+2.7	+4.4	+2.0	−0.8	−4.3	65.4	11.9	−55.5	+1.5	+0.4
Maxell Metal Vertex	+1.9	+7.2	+8.0	+8.2	+2.5	+4.4	+2.3	−0.6	−4.0	64.9	12.2	−58.1	+0.9	+0.6
Memorex CDX IV Metal	−0.1	+6.4	+7.0	+8.0	+2.4	+4.0	+1.8	−1.3	−4.7	64.4	11.6	−53.4	+3.0	−1.0
Realistic Supertape MIV	+0.5	+6.4	+7.0	+8.0	+2.4	+4.2	+1.9	−1.1	−4.6	64.2	11.5	−51.2	+2.7	−0.5
Sony Metal SR	+1.9	+7.3	+7.7	+7.5	+2.6	+4.2	+2.1	−0.7	−3.7	65.4	12.2	−53.1	+0.6	+0.6
Sony Metal Master	+3.1	+8.4	+9.5	+8.7	+2.1	+3.4	+1.2	−0.9	−3.7	67.8	12.3	−52.7	+1.8	+1.2
TDK MA	+2.0	+7.5	+8.8	+8.8	+3.1	+4.8	+2.4	−0.3	−4.5	65.9	12.3	−53.9	+1.1	+0.9
TDK MA-X	+2.8	+7.9	+8.8	+9.0	+3.2	+4.9	+2.8	−0.3	−3.9	66.0	12.2	−54.4	+0.9	+1.0
TDK MA-XG	+4.8	+9.9	+10.7	+8.9	+1.5	+3.7	+1.8	−0.8	−3.5	69.1	12.3	−51.8	+1.3	+2.2

Note: Modulation noise values are referenced to Dolby level; bias and sensitivity figures show how far each tape's requirements differ from the IEC Standard for its type.

relatively low SOL *and* comparably low noise will be rated equivalent to those with a greater SOL and comparably greater noise. And those that throw noise considerations to the wind in an attempt for more SOL take the chance of being downgraded accordingly.

There were 23 tapes in the Type II group. Average rating is 71%, with the rating of individual brands ranging from 56% to 85%.

BASF Chrome Extra II: Low noise typical of chrome. Decent MOLs. Treble SOL below average. Poor modulation noise. Superb 400-Hz uniformity. Good tracking. Busy J-card. Fair label. Overall rating: 71%.

BASF Chrome Super II: Better bass MOLs than Extra II, with little increase in hiss and less modulation noise. One-dB more high-treble SOL. Average level uniformity. Superb tracking. Busy J-card. Fair label. Overall rating: 74%.

BASF Chrome Maxima II: Even less hiss than Super II but at loss of 0.25 to 0.5 dB of MOL and SOL. Basically, a wash. More modulation noise and level irregularity reduce score. Similar J-card and label. Overall rating: 72%.

Denon S-PORT High (C-100): Low MOL/SOL, relatively high hiss and modulation noise, and swayback response lower the rating. Average otherwise. Slim case with rudimentary J-card and label. Overall rating: 61%.

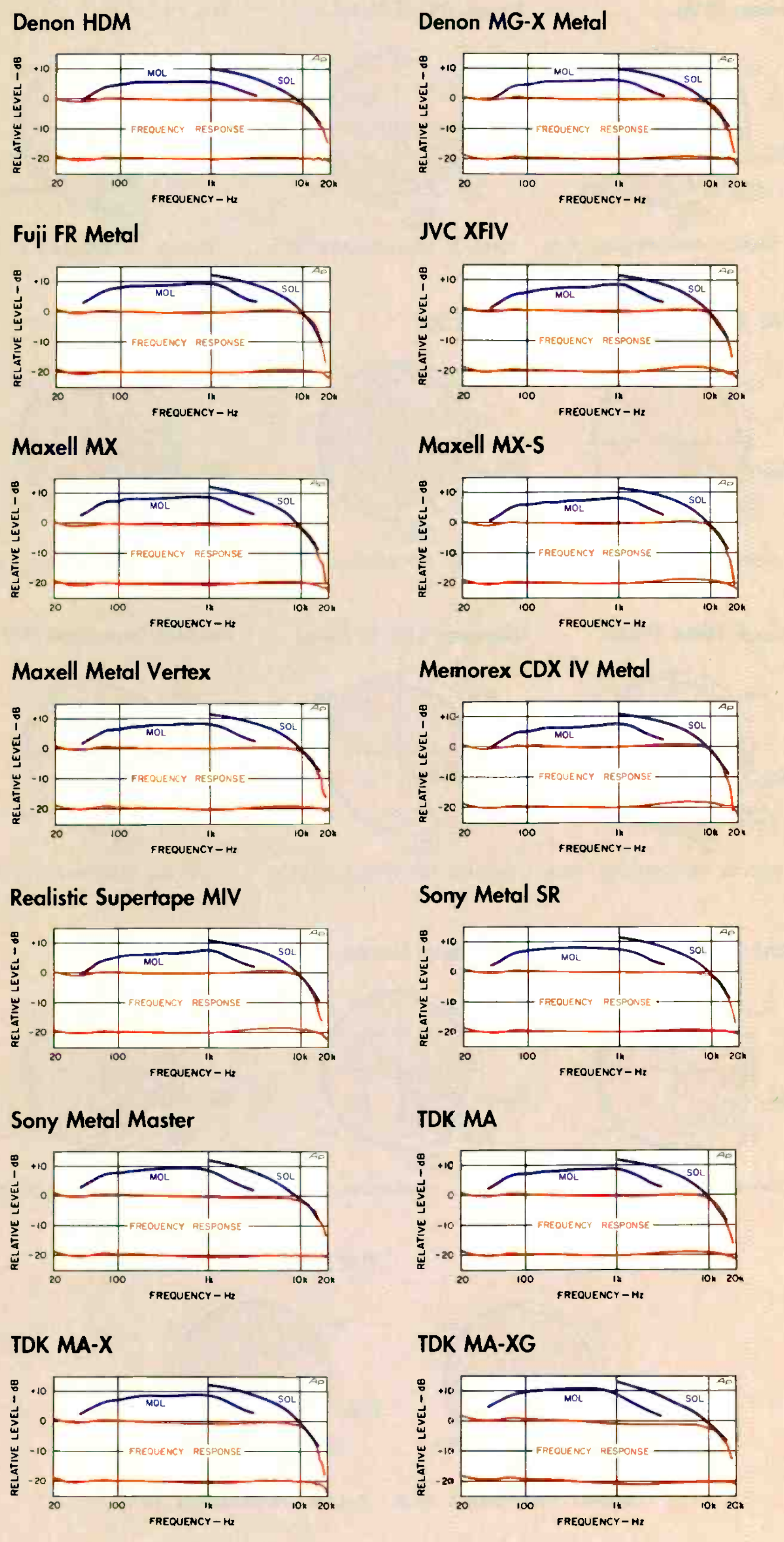
Denon HD6: Similar performance to S-PORT High but with slightly more modulation noise. Better than average level uniformity and response. Busy J-card, tiny label. Overall rating: 63%.

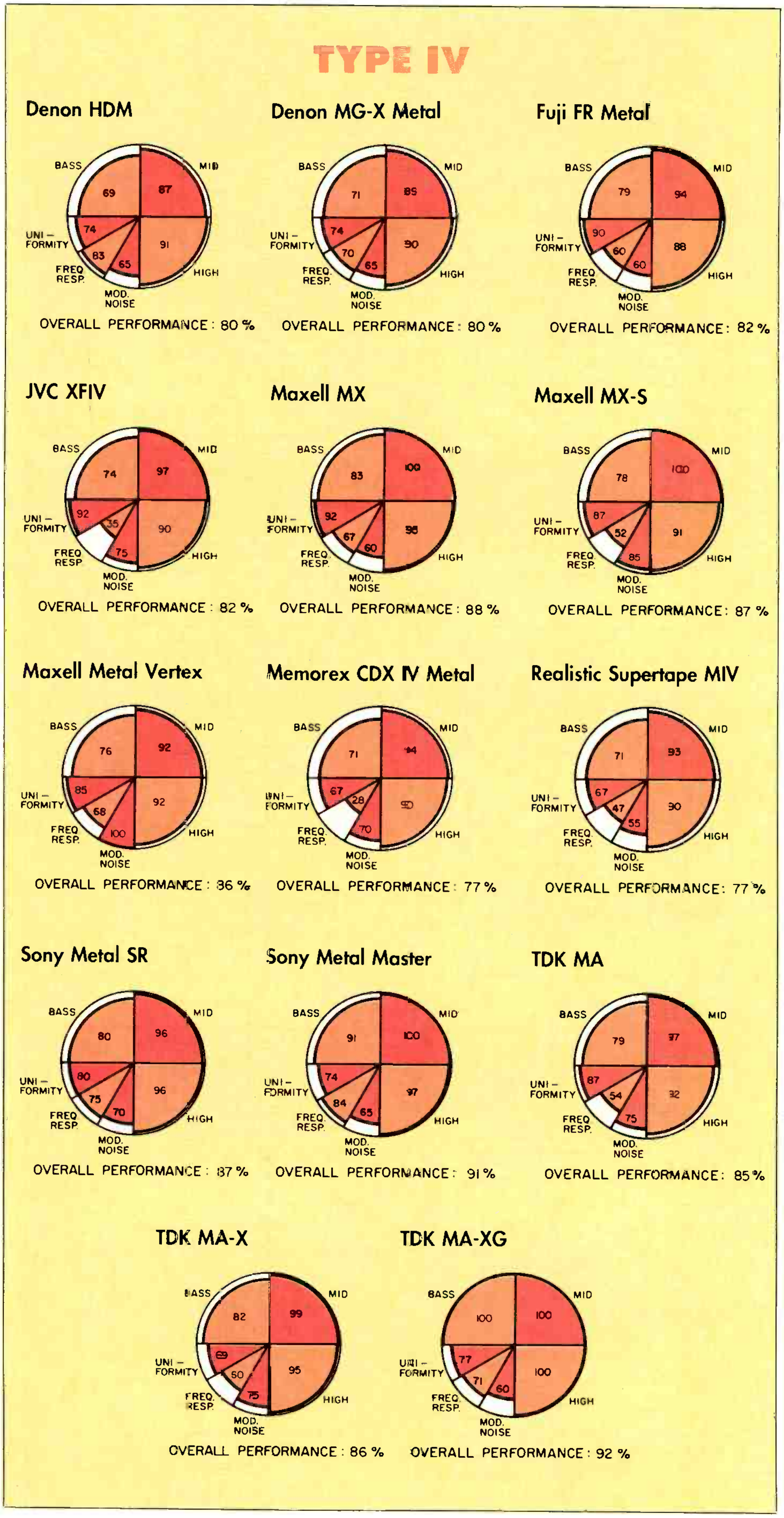
Denon HD7: Better MOL and SOL above 1 kHz, paired with reduced hiss and modulation noise, give HD7 the edge over HD6. Slightly worse level uniformity but excellent side A/B tracking. Busy J-card, tiny label. Overall rating: 67%.

Denon HD8: Exceptionally high MOL/SOL above 1 kHz from this metal-particle Type II, but high residual noise reduces ratings. High sensitivity may be a problem for many decks. Average level uniformity. Denon labelling. Overall rating: 62%.

Fuji DR-II: MOL just below average and SOL average, but noise is so low that DR-II gets fine scores. Uniformity is great at 400 Hz and 3.15 kHz, average at 10 kHz. Slim case necessitates tiny J-card. Overall rating: 78%.

TYPE IV





Fuji FR-IIx: More bass MOL, slightly less modulation noise, and no increase in hiss (re DR-II). Uniform output at all frequencies, but swayback response and high sensitivity reduce rating. Slim case, tiny J-card. Overall rating: 78%.

Fuji FR-IIx Pro: Further improved bass MOL, a tad lower modulation noise, and same residual noise combine to make Pro score higher than FR-IIx. Level uniformity good but tape downgraded for tracking and sensitivity. Slim case, tiny J-card. Overall rating: 80%.

Fuji ZII: Lowest noise of any Type II, best bass MOL from Fuji, and improved SOL. Sensitivity near normal. Good uniformity and better tracking than Pro improve rating. Slim black case, small J-card. Overall rating: 85%.

JVC AFII: Good SOL, but subpar MOL, high A-weighted noise, and poor level uniformity at all frequencies adversely affect AFII's ratings. Lower than average modulation noise. Adequate J-card and labelling. Overall rating: 56%.

Maxell XLII: Very solid bass and lower midrange MOL. Treble SOL falls off. Lower than average A-weighted and modulation noise. Average uniformity, fair tracking, but swayback response. Clean J-card and label. Overall rating: 76%.

Maxell XLII-S: Trades tad of bass MOL for improved SOL, but higher A-weighted noise reduces *all* scores relative to XLII. Lowest modulation noise by far of any Type II. Good level uniformity. Clean card and label. Overall rating: 75%.

Memorex HBSII: Somewhat better than average MOL and SOL are offset by higher than average noise. Good level uniformity. Fair tracking. Average modulation noise. Adequate J-card and label. Overall rating: 65%.

Realistic Supertape HD: Reasonably good SOLs are outweighed by subpar MOLs, relatively high A-weighted noise, poor tracking, and worse than average level uniformity. Coated J-card and fixed labels. Overall rating: 59%.

Realistic Supertape Premium MII: Metal-particle Type II tape with better than average MOLs and superior SOLs. Higher than average noise reduces ratings, and sensitivity differs widely from the norm. Coated J-card and fixed labels. Overall rating: 63%.

Scotch XSII-S: Well-balanced tape with average/above average MOL and SOL, average modulation noise, but above average A-weighted noise. Good uniformity and tracking. Swayback response. Clean J-card and label. Overall rating: 67%.

Sony UX: Average MOL and SOL aided by very low A-weighted noise. Good level uniformity but downgraded for tracking (side A and A/B) and very swayback response. Adequate label and J-card. Overall rating: 77%.

Sony UX-Pro: Improved MOL and SOL relative to UX, but higher noise more than offsets advantage. Lower modulation noise, slightly smoother response, and better tracking raise rating. Good J-card, tiny label. Overall rating: 78%.

TDK SD: Relatively weak bass MOL improves at 3.15 kHz. Solid SOL and low noise strengthen the ratings. Decent uniformity and tracking but relatively high modulation noise. Versatile J-card and label. Overall rating: 75%.

TDK SA: Has 1 to 2 dB greater MOLs and SOLs than SD at some increase in noise and more swayback response. Substantially lower modulation noise. Excellent uniformity and tracking. Versatile J-card and label. Overall rating: 76%.

TDK SA-X: Further improved MOL and SOL with a tad lower A-weighted noise and measurably lower modulation noise. Excellent uniformity and tracking. Rather high sensitivity. Versatile J-card and label. Overall rating: 79%.

TYPE IV TAPES

You usually pay a premium for metal-particle (Type IV) tapes, but, as a group, they outperform the others. The average score for the 14 tapes tested this year is 84%, 13 points higher than the Type II average and 32 points higher than the Type I average. This is not to say that all Type IVs are the same; scores ranged from a low of 77% to a high of 92%. But even the lowest rated Type IV outranked the best Type I, according to my grading system, although a couple of Type IIs edged out the lower ranking Type IVs.

What you get for your Type IV dollar is more headroom (especially from the midrange up) and, usually (but not necessarily), less modulation noise. On average, A-weighted noise is about 0.5 dB *worse* than

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Don't read too much importance into a difference of a few rating points between two cassettes.

the average Type II (almost 0.9 dB worse if I ignore the two "metal" Type IIs), so the better rankings for Type IVs come almost entirely from extra headroom. The moral is clear: To get the most from Type IV tape, record at a level a few dB higher than you would on Type II.

Denon HD-M: Relatively weak MOLs and SOLs for a Type IV, but noise is also a bit less than average and modulation noise is about average for a Type IV. Good response, fair uniformity and tracking. Busy J-card, tiny label. Overall rating: 80%.

Denon MG-X Metal (C-100): A bit better bass MOL and tracks better than HD-M, but response is slightly less uniform. Otherwise, C-100 MG-X is comparable to C-90 HD-M, which is admirable. Busy J-card, tiny label. Overall rating: 80%.

Fuji FR Metal: Exceptional MOLs and SOLs from 1 kHz up but ratings reduced by high noise level. Good uniformity at 400 Hz and 3.15 kHz, fair at 10 kHz. Tracks well on side A, fair on B. Slim case, tiny J-card. Overall rating: 82%.

JVC XFIV: Very good MOLs and SOLs from 1 kHz up, with average A-weighted noise and fairly low modulation noise. Good tracking and excellent level uniformity but very swayback response. Clean J-card, small label. Overall rating: 82%.

Maxell MX: Very solid MOLs and SOLs, with below average A-weighted noise. Does very well, especially in midrange and treble. Excellent tracking. Fair level uniformity. Nice J-card, label, and packaging. Overall rating: 88%.

Maxell MX-S: Less noise than MX, but lower MOLs/SOLs negate advantage. Very low modulation noise. Excellent tracking on side A, not on B. Good level uniformity except at 10 kHz. Nice J-card and label. Overall rating: 87%.

Maxell Metal Vertex: Lowest modulation noise of all. Good MOLs and SOLs but more A-weighted noise than most. Below average 10-kHz uniformity and tracking. Unusual J-card and label. Overall: 86%.

Memorex CDX IV Metal: Low sensitivity and an extremely high bias requirement may be a problem on some decks. Good midrange MOL but very swayback response. Average noise. Good treble uniformity. Okay J-card, small label. Overall rating: 77%.

Realistic Supertape MIV: Requires exceptionally high bias. Average A-weighted noise and relatively poor modulation noise. Average level uniformity and tracking. Rudimentary J-card, permanent labels. Overall rating: 77%.

Sony Metal SR: Balanced MOLs and SOLs, with better than average A-weighted noise and average modulation noise. Good bass/midrange level uniformity. Tracks well on side A, not as well on B. Small label, adequate J-card. Overall rating: 87%.

Sony Metal Master: Very solid MOLs/SOLs. Average bass/midrange uniformity, rather poor in treble. Tracks well. Flat response. Heavy shell, nice J-card, unusual labelling. Overall rating: 91%.

TDK MA: Solid MOLs and excellent SOLs. Very low modulation noise, average A-weighted noise. Excellent bass/midrange level uniformity. Good tracking. Swayback response. Versatile J-card and label. Overall rating: 85%.

TDK MA-X: Improved bass MOL and exceptional treble SOL. Slightly less A-weighted and modulation noise than MA. Smoother response but with slightly worse treble uniformity. Versatile J-card and label. Overall rating: 86%.

TDK MA-XG: Best bass MOL, best high treble SOL, lowest noise of any Type IV.

Unusual shell, with excellent tracking on both sides and fairly low modulation noise. Sensitivity possible problem. Nice J-card and label. Overall rating: 92%.

USING THE RESULTS

Although my ratings will distinguish the best tapes from the worst, please don't use them to split hairs. As I said before, the ranking of the top tapes (or the bottom group) would have changed had I rated differently. For example, had I considered consistency or uniformity more or less important than I did, shifted the weighting among my three frequency bands, or made any of a number of other permutations, the relative rankings of the tapes would have changed.

In the pie charts, Tables, and individual write-ups, I've tried to give *you* enough information to adjust the ratings for your personal needs. For example, if you're recording music from the classical or baroque periods, you probably don't need as much treble capability as you would to record synthesized rock or even the more modern classical repertoire (which is likely to make greater use of cymbals, triangles, etc.). In this case, a superior high treble score doesn't buy you much; for this application, look instead for superior performance in the bass and midrange regions.

Use the MOL and SOL figures in the Tables—together with your best idea of the energy distribution of music—to estimate the most appropriate recording level. For example, if you peruse the Tables, you'll find that many Type I tapes have better upper-midrange/lower-treble MOLs and SOLs than the typical Type II tape. This suggests that, for a lot of music, you should record at a *higher* level on a good Type I tape than on a Type II—despite the indications to the contrary that appear in most instruction manuals and on deck level indicators that display "suggested limits." I do this regularly, and I'm rewarded with some fine-sounding tapes.

If your deck has adjustable bias *and* record calibration controls, you should be able to use just about any tape in the list and obtain results that parallel mine. (There are a couple of Type IVs, however, that require *so* much bias, you may have difficulty attaining it on some decks.) If you're not blessed with bias and record calibration controls, it's hard to predict what results you'll get.

Choosing tapes with bias and sensitivity figures close to 0 dB—i.e., close to the IEC reference tape—does *not* guarantee performance, especially when using Type II and Type IV products. The Type II IEC Standard is a *chromium dioxide* formulation, whereas most Type II tapes are formulated from cobalt-treated gamma ferric oxide, which exhibits greater sensitivity and requires more bias than the "reference." And, as the test data indicates, modern Type IV tapes also seem to differ from their IEC reference. I took all this into account when computing uniformity scores, because, for the most part, deck manufacturers do *not* adjust their products to IEC Standards but to their own internal standards: They use the tapes which they consider to be best suited for their decks. If you know a tape that mates well with your deck and you wish to try others, look for those that most resemble it in bias and sensitivity requirements. Don't go by simple agreement with the IEC reference. A


D E E P
BASS
SUBWOOFERS

Takeaki Anazawa

David Ranada

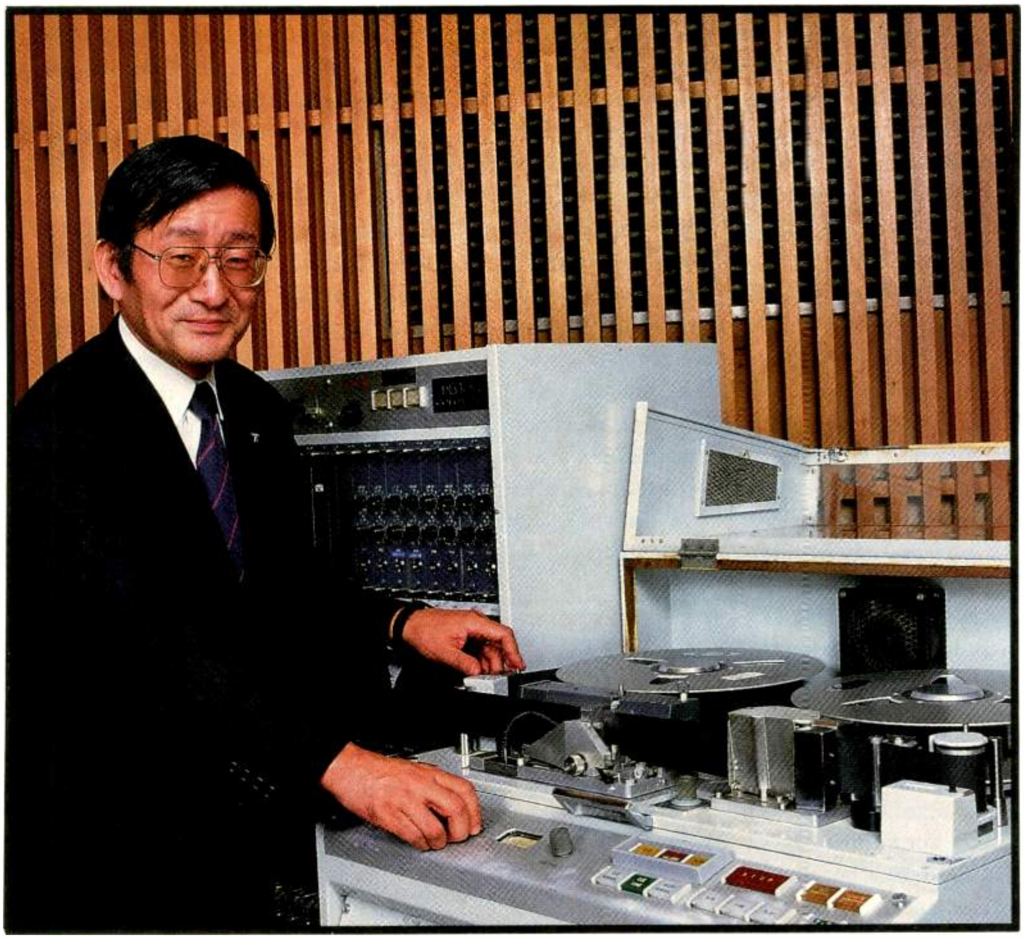
Mr. Takeaki Anazawa is one of the pioneers of digital audio technology, having been instrumental in developing the world's first eight-channel studio PCM recorder at Nippon Columbia (parent company of Denon). He headed the recording team that used the recorder to make the first digitally mastered commercial recordings in Japan, Europe, and the United States. His accomplishments also include leading the development of a disk-based digital audio editing system and a digital mixing console as well as, in his capacity as recording engineer, a great many digital audio recordings.

In 1992, Anazawa received the Silver Medal from the Audio Engineering Society in recognition of his contributions to digital audio recording and editing. He is now the General Manager of the Engineering Department of Nippon Columbia's Recording and Engineering Division and is working on optical-disc multimedia technologies, among other things.

This interview was conducted in English at *Audio*'s New York offices and has been lightly edited for clarity. *D.R.*

Mr. Anazawa, you were one of the very first persons in the world to make digital audio recordings. How did you first get involved with digital audio?

I think there are several reasons I was interested in digital recording. When I was a high school student I was very interested in audio, and I had a feeling that frequency modulation was a key issue in audio distortion. In the university, I studied acoustics and especially the correlation coefficient between the ears in a sound field [measuring the perceptual effects of having similar or different sounds at the two ears]. For the measurement of the correlation coefficient of human ears, the phase characteristic of



any recorder is very critical. I had used an existing analog tape recorder, and it was very difficult for that reason. We wanted a very accurate recording medium.

In the late 1960s, many different groups wanted to improve audio quality. For instance, the broadcasting people noticed that real-time transmission was much better than transmission off a tape recorder. That's why the NHK's [Japan's nationwide public broadcasting service] technical lab started to develop a digital recorder. I think that was 1966 or '65. In 1967, NHK had their first mono recorder.

The Audio Interview

Many record companies, especially Nippon Columbia [Denon], were also trying to improve the sound quality. Nippon Columbia, for instance, introduced a master-pressed vinyl disc—without using a stamper—in order to eliminate the sound quality loss. There were also the 12-inch, 45-rpm record and a tracing simulator to compensate for stylus tracing error.

In the late 1960s, Nippon Columbia had a chance to make a direct-to-disc recording [as in the 78-rpm era]. We had made some recordings of jazz and flamenco. The sound was very good; we were very impressed. Many audio fans loved that sound. But there was no editing capability in direct-to-disc. Nippon Columbia wanted to have the capability of editing a recording with the same [sonic] quality as direct-to-disc. At that time, many companies were proposing many different kinds of quadraphony. However, Nippon Columbia's recording engineers were much more interested in digital. Of course, we were working on quad too. But from the viewpoint of the recording engineer, we had to have very good recording capability first—then we could apply this capability to new products, such as quadraphonics. The recording method was the first step; surround stereo or quadraphonics was next. We had the chance to work with NHK, and we made many test recordings in our studio, about 30. This was in 1969 and 1970.

At around that time, NHK had completed their first stereo [digital] recorder. We went to them, and we hired their equipment and made many evaluation tests. The sound was okay, and the frequency modulation noise was lower than in the usual analog system. Then Nippon Columbia's recording engineers, including me, decided to use digital for our next project. We established a joint development project with NHK because we could not edit with their recorder, and the reliability was very bad.

I had tried to make a black [LP] disc from these test sessions. I spent almost a month every day sitting in front of the cutting lathe. One side was nearly 22 minutes. For the first 20 minutes it always seemed okay, but all of a sudden I got a big noise, a click from a digital error. We could only make two records from these 30 or 40 sessions. One was a jazz recording, the other a percussion program. It was not necessary with this music to have editing, just a live performance. We released these discs in 1971. At the same time, while we were having evaluation tests of the NHK recorder, we were developing our own recorder.

Are these recordings the first ones made digitally?

I think so. In 1971 we released these two titles. Later we wanted to release them on CD also. We still have the original tapes, but unfortunately we cannot play them. The machine does exist, but the NHK lab changed the encoding format every three months. That was an experimental project, and they did not keep the original format.

At the beginning of 1972, we completed our own digital recorder. That was a huge machine. It used a two-inch, four-head ["quad"] Ampex videotape recorder. The reason why we used such a videotape recorder was very simple—at that time it was the only reliable recorder available. Also, the heads rotate vertically [almost directly across the width of the tape], and it is quite easy to cut the tape. Therefore, mechanical editing was possible.

How many bits was this machine?

It was a very interesting recorder. It had eight channels of 13-bit A/D converters. The sampling frequency was 47.25 kHz, three times the video horizontal scanning rate. In a helical-scan videotape, you cannot put data in the vertical synchronizing field, but with this type of videotape recorder, we could put the data in the vertical synchronizing area also. That's the reason for that sampling frequency.

At that time, error correction was very simple and poor. We adopted a very primitive method, a parity scheme. It was not sufficient for our reliability requirements, but we did not have enough time to evaluate other schemes. We reached a very simple solution. The recorder was eight channels, so in the case of a four-channel recording we made a double recording. With two channels, we made a double-double recording.

> †
>
> My biggest concern as a recording engineer is how to satisfy and entertain the people.
>
> †

That's 400% redundancy!

Yes.

Was that machine the first one to be used to make extensive digital recordings?

Yes, in the beginning of 1972 (March/April) we started recording. One of the first sessions was Mozart played by the Smetana String Quartet. That machine had certain features which made it quite unique, and we cannot achieve certain of its capabilities even in current machines.

What were some of those capabilities?

The easiest way to get higher quality in the high-frequency range in analog discs is half-speed cutting. So that machine had half-speed playback. Also, we could get an advance signal [to control the groove spacing of an LP cutting lathe] by using a preview head in the videotape recorder.

How often was tape cutting used for edits? I would imagine using tape-cut editing on that machine would be fairly unreliable.

Actually, that's a secret. It has to be confidential in order not to disillusion the classical music lover. Usually for a normal classical music production, there would be 100 editing points per LP or CD—at least 30 and up to 200.

We cut tape many, many times. We put iron powder on the tape so we could see the recorded track through a microscope, and we cut between the tracks with an ordinary razor blade.

At that time there was no cross-fade capability, which was a very big problem for us. So we developed some digital memory circuits [to temporarily store a fraction of a second of audio]. The splicing tape we use was aluminum backed; it reflected light. We put a light detector near the head assembly, so the system got the information about the location of the editing point from the splicing tape. And the digital audio data was stored in memory and a digital multiplier cross-faded over the splice.

So there were from 30 to 200 of these mechanical edits for your first digital recordings?

Always. Now, splicing is not mechanical, but the number of edit points is still the same.

The two-inch videotape weighs about 10 kilos [22 pounds]; it's very heavy. Physically it was not so convenient for us. That is why we wanted to change to a smaller recording medium, such as U-Matic [¾-inch videocassettes] or VHS. In these media you cannot cut the tape. We still wanted to have editing capability, so we developed a hard-disk editing machine.

A year before, Dr. Thomas Stockham developed an editing machine using an existing computer. But at that time, the computer itself was very expensive. That was the reason we developed an editing system using a microprocessor, not a general-purpose computer. Thus, our editing concept was basically the same as the Soundstream concept.

This was still with 13-bit recordings?

That is an interesting story. At first we had originally 13 bits; I think NHK had 12 bits. Two years later [1974] we introduced pre-emphasis and de-emphasis. Then we could get [improved dynamic range by around] 9 dB, or about 14.5-bit equivalent recording. Fortunately, in our original [two-inch] format we had an empty space after the 13-bit data. After recording evaluation, we noticed that this space could be used. We put in additional data for 14-bit recording, so 14 bits with pre-emphasis and de-emphasis were equivalent to 15.5 bits.

Then in 1975 to 1976 we introduced U-Matic ¾-inch recording, and we changed to 16 bits. We still wanted to have four-channel recording capability. From the middle of the 1960s, all the leading European record companies, especially in the classical field, were using four-channel recorders, not only for quadraphony. That is why we wanted four-channel recording. When we shifted to a ¾-inch recorder from two-inch, we wanted to keep the four-channel capability. This was a fundamental and minimum requirement.

As you know, even now there are several ¾-inch formats that are very popular. But all of them have only two-channel capability. We evaluated many different kinds of ¾-inch recorders. There was a special U-Matic recorder made for hospital purposes. It was called an "X-ray" U-Matic because it had higher resolution than normal for recording for X-ray photographs. For X-ray pictures, color is not required but doctors need higher resolution. This kind of U-Matic recorder had a wider frequency range, using the same tape medium to support the higher resolution. This format was just sufficient for four channels. That was the reason we started to use the X-ray U-Matic recorder.

By the time X-ray U-Matic went out of production, the normal U-Matic had been improved. Now we only need to replace one capacitor and one resistor in order to play the four-channel tapes. Until now, this is what we have been using.

This machine carried you over the transition period from the LP to the Compact Disc?

We were very happy because around 1980—just before the Compact Disc era and enough time before to prepare for the CD—we introduced the 16-bit recorder, and we also introduced the hard-disk editing machine.

That was good timing.

Already by 1977, three companies were showing digital audio laser videodiscs. One was Hitachi/Nippon Columbia, the others were Sony and Mitsubishi. In the middle 1970s, I had to spend every weekend at the Central Research Laboratories of Hitachi to develop a digital audio laser disc. After 1977, many companies started to negotiate about standardizing a digital disc format.

That first Denon machine was 13-bit, and now recording engineers are looking to 18- or 20-bit machines. Could you comment on what you heard in those early days compared to what you hear now, in regards to sample size.

In 1982 to '83, we developed a new recorder. I designed the A/D and D/A parts. Those converters were 20-bit units; their actual accuracy was a little less than 18-bit. But those circuits combined two D/A converters, a 16-bit plus an eight-bit. The eight-bit unit had two purposes. The first was to expand the number of bits, but the second was to compensate for the errors in the 16-bit converter. It worked very well. We wanted a higher bit number than consumer products and also wanted better sound quality. This compensation circuit worked very well. Later it was used in Denon consumer products as the Super-Linear converter.

I had many interesting experiences in this field. For instance, our original recorder had 13 bits, and our next had 14 bits. With the 13-bit recorder, we designed the A/D converter ourselves and selected the resistors by hand. In the next generation we purchased existing A/D converters. The sound quality of the 13-bit was much, much better than the 14-bit. Accuracy is the most important issue, not so much the bit numbers, I think.

When we developed that A/D converter, we had to evaluate the analog parts very carefully (operational amplifiers, resistors, transistors). We had a kind of "acceleration" test. If we had to use an operational amplifier chip, we made a test system using 10 or 20 of them in series. If one amplifier had some quality loss, with 10 we could get a bigger and more obvious loss.

We carefully selected all the devices. The sound was very nice. Even now many engineers like that 10-year-old converter. That's the result of very carefully selected devices giving very good accuracy, not only a matter of the number of bits.

What do you think of the one-bit converters, like MASH and bitstream?

There are several types. One is MASH. It's not so important for me. A friend of mine at a university laboratory has developed a one-bit system with a very high sampling rate. Probably this method will give very good results. One of the major advantages of the one-bit concept is low cost, the cost saving for mass production. From the viewpoint of quality, we still must choose the best one. That means the most accurate method, whether it is one-bit or 16-bit.

Will we see greater and greater sample sizes? For example, DCC in theory will provide an 18-bit dynamic range.

To get a wider dynamic range is quite easy. With nonlinear encoding, even a 16-bit converter can handle a very wide dynamic range. But the sound quality is not only caused by dynamic range. Higher bit numbers are okay if the system has enough accuracy in its converters; it all depends on accuracy.

For instance, with the existing one-bit solutions, the total conversion characteristic is not so good. Near the zero-crossing point they are okay, but in total there is some nonlinearity. Also, the distortion or quantizing noise is shifted in frequency range, so the character of the noise is quite different from a standard, 16-bit successive-approximation converter. Personally, I now prefer conventional quantizing noise.

I know that many people don't like the 20-kHz cutoff filter necessary for such devices. But I'm a recording engineer, and I have to manage the entire frequency range. I personally would like to have that filter. Beyond 20 kHz, [there may be some] uncontrolled signals. I don't like that. If the system has some nonlinearity beyond 20 kHz, we would get that signal as audible distortion. This kind of thing I don't like. A recording engineer should prevent these kinds of things.

One of the complaints still dogging digital audio is the phase shift of anti-aliasing and reconstruction filters. What are your thoughts on this?

It's very strange for me. About 20 years ago, we were using SQ or QS or some other quadraphonic system, that all used very big phase shifters. At that time nobody mentioned the phase shifting, and still the impulse response was awful. Also at that time, we evaluated the phase shifting effect for human ears very carefully, looking for the point at which one could detect it. We found some effect of this type of phase shifting, but an anti-aliasing filter has far less phase shift compared to those quadraphonic phase shifters. Normally the phase shift of an anti-aliasing filter is the equivalent of moving a speaker's tweeter by one-inch either forward or back. I think the change is detectable, but it is not a big issue for normal audiences. Phase shifting at the anti-aliasing filter is not the issue: Many filters simply have bad sound characteristics. That's the big problem; it's not mainly caused by phase shifting.

Getting the best sound quality is very difficult. Using a very old technique—the LCR [inductor/capacitor/resistor] filter—the sound is very good. But you have to choose the "L" component very carefully, because ferrite [in the inductor coils] has some distortion that depends on the signal level and the impedance. With active filters, you have to use many operational amplifiers. Sound quality of operational amplifiers is one of the key issues for active filters. That's why we made many tests of operational amplifiers. Once we got a good one, then the sound-quality loss was not big.

We have been talking about linear PCM. The new DCC and MD data-compression systems are, at heart, anything but linear PCM. Are they a good thing?

Personally, I'm very interested in audio compression. But the purpose—first we have to think about the purpose. The main target of MD and DCC is the Walkman-type application; portability is one of the most important things here. Smaller media are very important, and in order to get the smallest media, they have to use compression methods. That is okay and acceptable. The purpose is not to get higher performance. That's a different issue.

> Our earliest digital recorder was unique; we can't achieve some of its capabilities in current machines.

Can you actually get higher performance using a compression system?

A 16-bit high-fidelity audio signal's entropy [the true information content of the signal] is four bits or less per sample. If the original music were recorded with 20 bits, it would be a little different. But in the case of 16 bits, the entropy is one-fourth of the full data rate. That means if we have a very sophisticated encoder and encoding algorithm, we could keep the same quality down to four bits per sample without any loss. But this is not so easy, because it depends on the algorithm and the music. Such a process would be very complicated. A 50% reduction would be much easier. Probably then we could get higher performance than 16-bit. MD and DCC have far from ideal encoders, but they are reasonably good for portable applications.

Using the MD algorithm, the compression ratio is about five. This means that you can put at least eight channels of audio on a full-size CD, using MD compression. We've made some tests, using the standard CD data-transfer rate but changing the number of channels and the number of bits. The results depend on the music and the location of the loudspeakers. With two channels compressed, the sound quality is not better than the original. But if we have four channels with good, well-placed speakers and well-recorded music, then it works better than two-channel compressed audio and even better than two-channel 16-bit audio.

Is this the direction audio will be going, to multiple-channel systems?

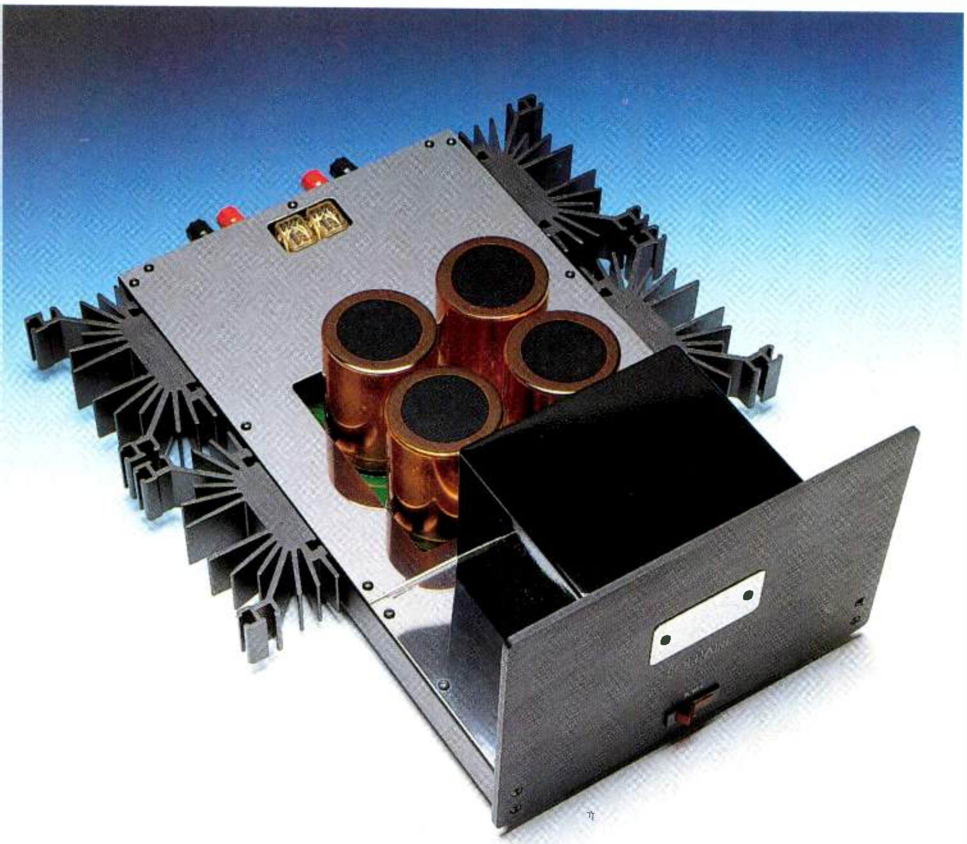
I don't know exactly, but this is one of the possibilities. I'm a recording engineer. The biggest concern for me is how to satisfy or how to entertain the people. Using different numbers of channels and such are just parameters.

Until now, the hardware manufacturer has supplied a single-purpose player or recorder. If you want a four-channel player using the MD compression method or a five-channel player using the DCC algorithm, the consumer would have to buy different kinds of single-purpose players. That's not a good idea at all. Even now, the home has so many different kinds of hardware and their remote controls, it's impossible to use the right one!

For the future, hardware products should have some algorithm-independent capabilities. This means the hardware should support different kinds of algorithms. And the hardware should have some scalability to provide different numbers of channels, or sampling rates, or sample sizes. Achieving such depends on future standardization. A

EQUIPMENT **PROFILE**

METAXAS SOLITAIRE AMPLIFIER



I first encountered Kostas Metaxas at the 1992 Winter CES and was impressed by the man, by the range of products displayed in his company's demo room, and by the sound of those products. Metaxas Audio Systems hails from Australia. They make a number of electronics pieces, including several preamps, three power amps, and some interesting full-range electrostatic speakers. Other new products are in the making.

The Solitaire amplifier reviewed here is an unusual looking package rated at 130 watts per channel into 8-ohm loads and is said to be very wideband and fast. Some Metaxas literature claims a power output in excess of 100 watts per channel into any known speaker load, from d.c. to well over 500 kHz; I was reluctant to test that bandwidth spec until I had done the formal measurements and had my fill of listening!

The Solitaire is a near dual-mono design, with the common elements being the chassis and the power transformer. The overall layout ensures a very short signal path from input to output, including the current path from the power-transformer secondary windings and the rectifier and filter capacitors. The front-end circuitry consists of a complementary differential cascode arrangement feeding a complementary second stage that I usually call the "last voltage amplifier" (LVA). The differential input amplifiers don't use solid-state current sources but are connected by good old-fashioned resistors to the appropriate supply rails. The collectors of the LVA, tied together through a bias-spreading regulator, feed a series of three Darlington-connected complementary emitter followers, of which the first two are drivers and the last is the actual output stage.

All the circuitry above, including the first output-stage driver, is powered by complementary Darlington-connected capacitor-multiplier "regulators" fed from the main rectified power-supply rails. Capacitor multipliers divide the input d.c. voltage down by a small amount and bypass the lower arm of the divider with a large capacitor. This divided and filtered voltage is fed to the base of an emitter follower, in this case a Darlington-connected one, and the emitter is the multiplied output. This provides a low output impedance, with the value of the capacitor connected from base to ground multiplied, in effect, by the beta of the transistor(s).

Back to the main signal path: A second complementary emitter follower drives

SPECS

Power Output: 130 watts rms per channel into 8 ohms, with less than 0.25% THD; 250 watts/channel into 4 ohms.

Rated THD: 0.05%.

Slew Rate: 1,000 V/µS.

Frequency Response: D.c. to 500 kHz, +0, –3 dB.

S/N: 117 dB, unweighted.

Gain: 28 dB (0.8 V rms in for 40 watts out).

Dynamic Headroom: 6 dB.

Damping Factor: Greater than 500, wideband.

Input Impedance: 130 kilohms and 56 pF.

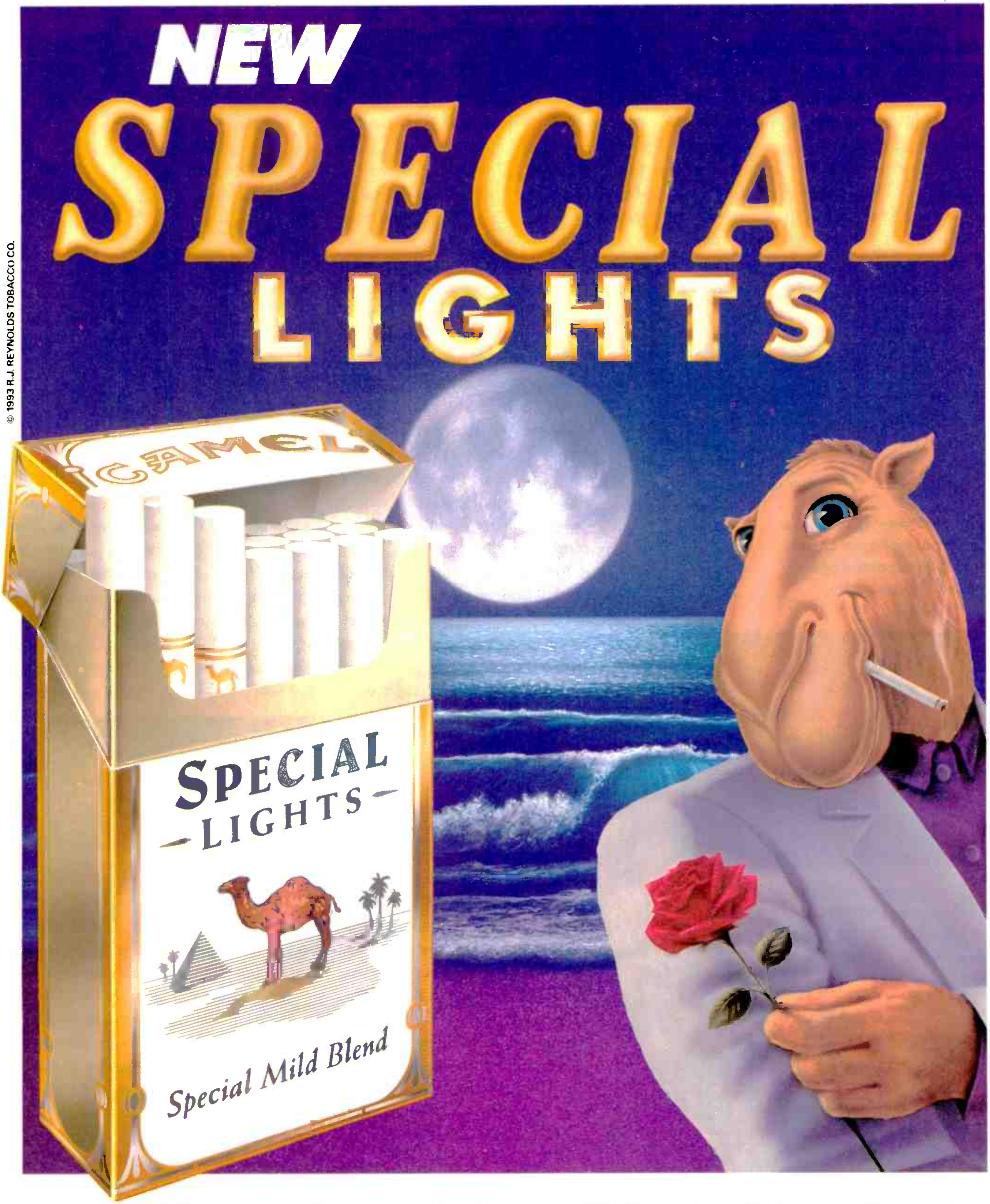
Dimensions: 16⁹⁄₁₆ in. W x 7⅞ in. H x 19⁵⁄₁₆ in. D (42 cm x 20 cm x 49 cm).

Weight: 65 lbs. (29.5 kg).

Price: $3,800.

Company Address: 230 Rae St., North Fitzroy, Victoria, Australia 3068.

For literature, circle No. 90



Taste Camel In a Whole New Light

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11 mg. "tar", 0.8 mg. nicotine av. per cigarette by FTC method.

four pairs of very fast (80-MHz gain-bandwidth product) output transistors. No Zobel (series RC) stabilizing network across the output line to ground, or parallel RL output-buffering network in series with the hot output, is used. The only stabilizing elements, at least according to the schematic, are a pair of small capacitors between the collectors and bases of the LVA transistors. A passive RC input filter reduces response above the designed bandwidth of

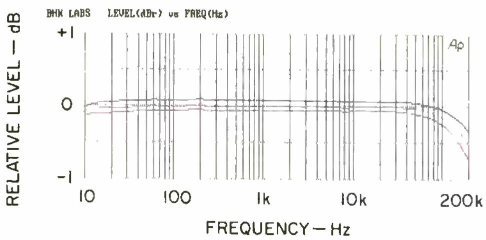


Fig. 1—Freqency response for (from top) open circuit, into 8 ohms, and 4 ohms. Note the close match.

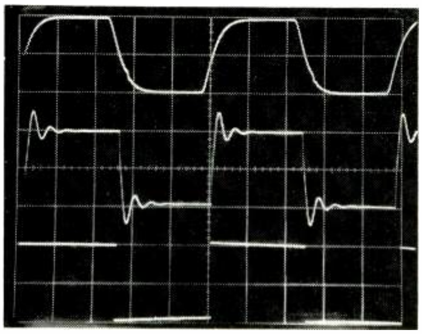


Fig. 2—Square-wave response of (from top) *200* kHz, 8 ohms (1 µS/div.); 10 kHz, 8 ohms & 2 µF (20 µS/div.); 40 Hz, 8 ohms (5 mS/div.; all 5 V/div.).

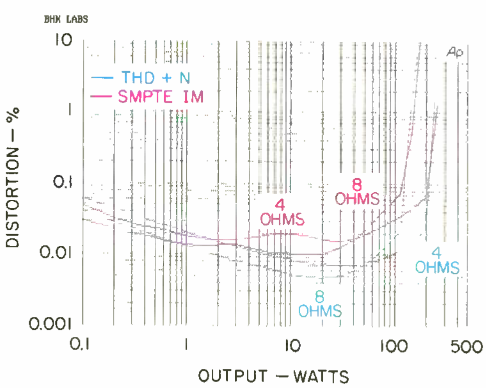


Fig. 3—Distortion vs. power.

the amplifier circuit itself. All devices are bipolar transistors. A claimed 11 dB of overall loop feedback is employed, and an op-amp servo keeps overall d.c. offset to low values. Of course, the use of a d.c. servo negates the possibility of audio response to d.c., since servo circuits ultimately reduce the subsonic a.c. gain to a value less than what it is in the audio frequency range. Topologically, this circuit is a lot like other designs I've seen over the years, but to my knowledge, none of them were as fast as this design. Part of the reason for this wide power bandwidth is in the p.c. board design, which borrows from r.f. and ground-plane technology to maximize the speed of current delivery at high frequencies. A turn-on/turn-off time-delay and protection circuit operates a relay in series with the speaker terminals.

Another interesting circuit departure from convention is the use of a large number of small rectifier diodes in parallel instead of the customary single high-current bridge rectifier, which is slower.

Measurements

My first measurements were of gain (30.3 dB for the left channel, 30.2 dB for the right) and sensitivity (86.8 and 87.3 mV for the left and right channels, respectively). Then I measured frequency response at an output level of 2.83 V (equivalent to 1 watt into 8 ohms) for 8-ohm, 4-ohm, and open-circuit loads (Fig. 1). As can be seen, the response is essentially unaffected by load.

Square-wave response for this amp is shown in Fig. 2. The top trace is for *200 kHz!* I couldn't help using this much higher than usual square-wave frequency to illustrate that this amp is indeed fast. Measured rise- and fall-times were about 0.6 µS, giving an equivalent upper frequency response limit (+0, –3 dB) of some 583 kHz. The little glitch on the negative-going transition is a fairly insignificant flaw; since its duration is some 200 to 300 nS, its energy is well out of

the audio frequency band. With a more normal square-wave frequency of 10 or 20 kHz, the waveform would remain exponential even if I ran the level up quite a bit higher than the 10 V peak to peak shown. (Remember, I didn't want to risk the possibility of rendering this amp unplayable, as I hadn't fully assessed its sonic properties yet.) In the middle trace of Fig. 2, we have a 10-kHz square-wave frequency with an 8-ohm load paralleled by 2 µF of capacitance.

AT 500 kHz, THE AMP COULD SQUEEZE OUT "ONLY" 80 WATTS PER CHANNEL—STILL PRETTY DAMNED IMPRESSIVE!

Ringing here is typical of other transistor circuits and shows that even though the rise-time of the amp into a resistive load is blazing, it still can't deliver the current that fast into a high-frequency short (the capacitor), as evidenced by the slower rise-time in this trace. In the bottom trace, for 40 Hz, there is some low-frequency roll-off (not much, mind you, but some), evidence that the reponse does not go down to d.c.

Figure 3 shows THD + N and SMPTE-IM distortion as functions of power output and loading. (The 3-ampere fuses in the power-supply rails blew during my tests with 4-ohm loads, as the approximate average current per rail is about 3.8 amperes under those conditions. I therefore replaced them with 4-ampere fuses, despite

THE DIGITAL DECONVOLUTION AUDIO SYSTEM

DGX Audio's DDAS System Delivers Precise Localization, Separation And Imaging

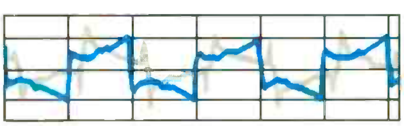
An ideal loudspeaker would convert electrical signals to sound pressure with flat frequency response, no phase distortion and no coloration. The reality, however, is that *all* loudspeakers exhibit certain imperfections when reproducing audio signals. The most significant—audible—anomaly is acoustic smear or a "blurred" soundstage caused by improper dispersion characteristics. This blurring distortion is the result of a physical process called "convolution." Until DGX's introduction of the Digital Deconvolution Audio System (DDAS), no product—in any price category—has been able to bring the hi-fi enthusiast an audio system devoid of acoustic smear.

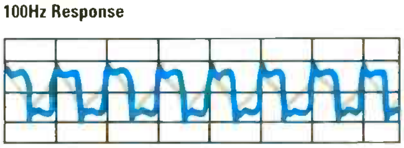
The DGX Deconvolution Processor

The DDAS system is comprised of the DDA-1 digital signal processing (DSP) amplifier and a pair of DDL-1 three-way bass-reflex loudspeakers. The heart of the system is the DDA-1's DSP circuitry featuring DGX's proprietary "Deconvolution Processor," that uses a fully patented method to virtually eliminate acoustic smear. To substantiate this claim, the waveform graphs below clearly show the remarkably accurate acoustic square-wave reproduction of the DDAS system—unmatched in the industry.

Speaker sound pressure measurement for square wave input

ORIGINAL — DECONVOLVED


100Hz Response


1kHz Response

The DDA-1 100-Watt/ch. Digital Deconvolution Amplifier and DDL-1 Three-Way Bass-Reflex Loudspeakers.

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the admonition in the owner's manual not to use fuse values larger than 3 amperes.) Results are shown for the right channel, which was slightly higher in distortion than the left channel.

Table I—Output noise. The A-weighted IHF S/N ratio was 82 dB for the left channel and 72.7 dB for the right.

	Output Noise, μV	
Bandwidth	LEFT	RIGHT
Wideband	741.0	2,030
22 Hz to 22 kHz	700.0	2,030
400 Hz to 22 kHz	204.0	598.1
A-Weighted	226.0	658.0

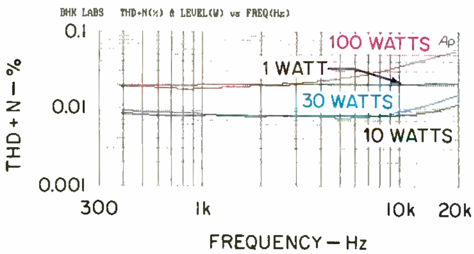


Fig. 4—THD + N vs. frequency as a function of power into 8-ohm load.

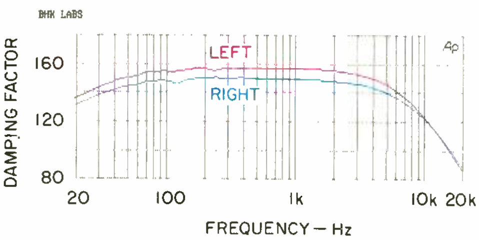


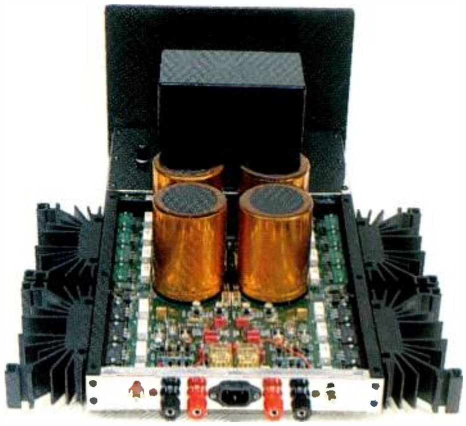
Fig. 5—Damping factor vs. frequency.

Total harmonic distortion, as a function of frequency and power for 8-ohm loads, is shown in Fig. 4. Even though the bandwidth of this amplifier is so high, distortion does start to rise in the audio range, as can be seen in the figure. The distortion at lower power levels was dominated by line harmonics rather than distortion per se; accordingly, I used a 400-Hz high-pass filter to cut off the measurements. Spectrum analysis (not shown) revealed a second-harmonic component of about 0.0025% in the right channel, with the rest of the spectrum mostly made up of line-harmonic components. The left channel, however, had much lower noise, so more discrete distortion components could be seen, including a decreasing series down to the sixth harmonic.

Output noise levels are enumerated in Table I. Noise levels are dominated by line-harmonic (hum) components at a fundamental frequency of 120 Hz. The waveshape of these hum components looks like the effect of charging current pulses in the main filter or smaller bypass capacitors tied to the main supply line. In my opinion, the left channel was only marginally quiet, and the noise in the right channel was outright too much.

Crosstalk between channels was found to be down more than 90 dB over the audio range in the left-to-right direction, with the exception of the aforementioned hum components (which aren't crosstalk per se but do show up in the measurement). In the right-to-left direction, crosstalk was again better than 90 dB down, including the hum components, but started to rise at about 1 kHz, crossing over the –90 dB point at 3 kHz and ending up at –83 dB at 20 kHz.

Damping factor for both channels is plotted in Fig. 5. The higher damping factor is for the left channel. Notice the dip at 120 Hz for the right channel. That is the 120-Hz fundamental hum component showing up in this measurement. The basic technique in measuring damping factor is to inject 1 ampere of current into the measured channel's output terminals, with the signal input jack terminated by 1 kilohm, and then measure the voltage appearing across the output terminals. Since the injected current is 1 ampere, the measured voltage across the output is directly convertible to ohms of output impedance. However, any noise or hum in the output of this measured but undriven channel can raise the voltage measured in this test, contaminating the results. Since damping factor is really 8 ohms divided by the measured output impedance, a small rise in level at hum frequencies will appear as an apparent dip in damping factor.



In dynamic power testing, the Solitaire's dynamic clipping power was found to be 150 watts into 8 ohms, for a dynamic clipping headroom of 0.62 dB. Into 4-ohm loads, the dynamic clipping power at the visual onset of clipping was 288 watts. Steady-state clipping power at the visual onset of clipping was 134 and 220 watts into 8- and 4-ohm loads, respectively. This yields a clipping headroom of 0.13 dB for 8-ohm loading.

The Solitaire's d.c. offset measured less than 1 mV in each channel. The a.c. line current at idle was 0.72 ampere, indicating a moderate idling power dissipation that gets the heat-sinks warm to the touch. Power-supply rails were ±55.3 V for a 120-V a.c. line input.

After a thorough listening evaluation, I returned the amp to my lab to look a little closer into its ultrasonic power capabilities. Driving a 20-kHz signal into clipping with 8-ohm loads showed some signs of "sticking." A sweep of distortion versus power output with 8-ohm loads and a 200-kHz test signal (not shown) revealed that distortion stayed under about 0.6% for both channels up to 100 watts, and visual onset of clipping occurred at about 120 watts. At 400 kHz, again with 8-ohm loading, I got about 100 watts per channel at the onset of clipping. Finally, at 500 kHz, I could squeeze about 80 watts per channel out, though the waveform was starting to look more triangular than sinusoidal. Although this doesn't quite meet the Solitaire's spec for high-frequency power, what the amp does do is pretty damned impressive, if you ask me! Definitely not something to try on most other solid-state amps!

Use and Listening Tests

Ancillary equipment used to evaluate the sonic properties of the Metaxas Solitaire

Continued on page 78

EQUIPMENT PROFILE

DAHLQUIST DQ-30i LOUDSPEAKER

The last Dahlquist loudspeaker reviewed by *Audio* (the M-907i, August 1990) was a conventional box. The DQ-30i, Dahlquist's most expensive system, follows the successful, patented Phased Array Technology design introduced with the firm's first model, the DQ-10, in 1974.

Phased Array Technology addresses two main areas: The minimization of time-based errors by proper driver positioning and the careful elimination of re-radiated sound by controlling diffraction through such features as raised grille frames, specially shaped and smoothed baffles, and flock coatings on baffle surfaces. In addition, each driver's baffle is designed to be as acoustically small as possible, to minimize diffraction and cabinet colorations, and yet sized and shaped so as to maximize driver efficiency.

Dahlquist also pays close attention to minimizing cabinet resonances and unwanted mechanical coupling. In the case of the DQ-30i, this yields, in their words, a "wide open, un-boxy" sound. Both the woofer and separate midrange enclosures have nonparallel sides to inhibit standing waves. The trapezoidal midrange enclosure is only connected to the woofer enclosure indirectly, through metal support rods. (The tweeter is in an open-backed, foam-filled baffle.) The woofer baffle is reinforced with a secondary baffle to increase cabinet rigidity and minimize front-panel flexure.

The DQ-30i looks like no loudspeaker you've seen before. Its most distinctive feature is its bold, swept-back curved grille. The mid/high driver module is enclosed on three sides by hole-punched sheet metal, with a high proportion of open space, held by a metal framework. This assembly provides a very open, acoustically transparent covering. The flexible grille is made from a similar open-punched metal, covered by cloth and held in place by ribbon magnets around its periphery.

The system utilizes a 10-inch woofer in a vented box, tuned to what Dahlquist calls a

SPECS

System Type: Three-way, floor-standing, phased-array, vented second-order quasi-Bessel system.

Drivers: 10-in. cone woofer, 5-in. cone midrange, and ⅞-in. aluminum-alloy dome tweeter.

Frequency Response: 23 Hz to 27 kHz, +0, –6 dB; 27.5 Hz to 27 kHz, +0, –3 dB.

Sensitivity: 89 dB at 1 meter, 2.83 V rms applied.

Crossover Frequencies: 280 Hz and 3.2 kHz.

Nominal Impedance: 4 ohms.

Recommended Amplifier Power: 25 to 250 watts per channel.

Dimensions: 47 in. H × 17½ in. W × 15 in. D (119.4 cm × 44.5 cm × 38.1 cm).

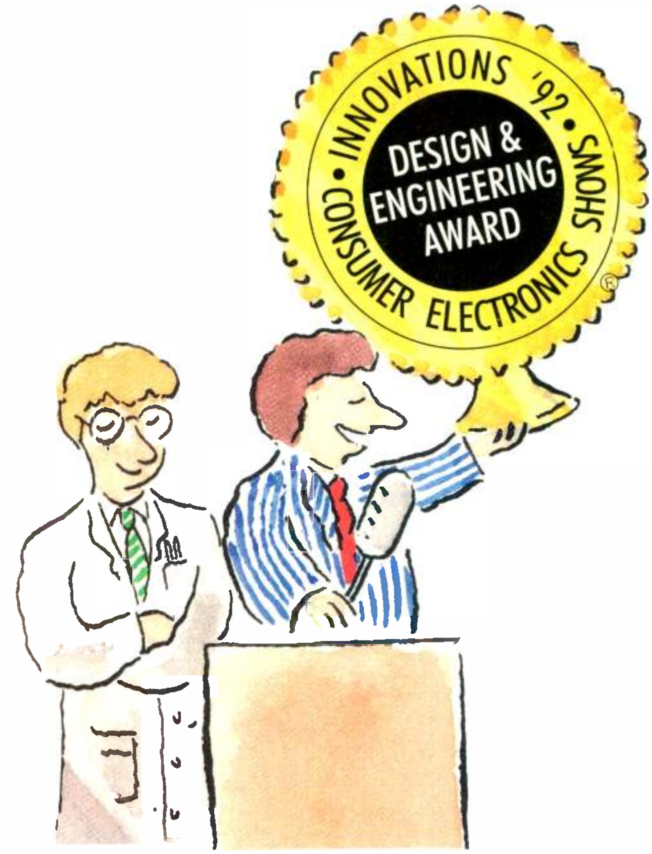
Weight: 95 lbs. (43.2 kg) each.

Finish: Black burled or rosewood finish on metal trim.

Price: $2,000 per pair; optional spiked base for use on carpet, $200 with trade-in of old base.

Company Address: 601 Old Willets Path, Hauppauge, N.Y. 11788.

For literature, circle No. 91



"We wish to thank Mom; our 3rd grade music teacher; the members of the Academy..."

The Multi-Channel GFA-2535: yet another award-winning amplifier from Adcom.

A pattern appears to be taking shape here: Adcom introduces a new power amplifier, Adcom wins an award. The GFA-535, GFA-555, GFA-555II, GFA-565, and now the GFA-2535 — every single one has earned the immediate praise and plaudits of the industry's most respected authorities...perhaps because Adcom packs more performance and innovative technology into its amplifiers than you'll find in components that cost twice as much or more.

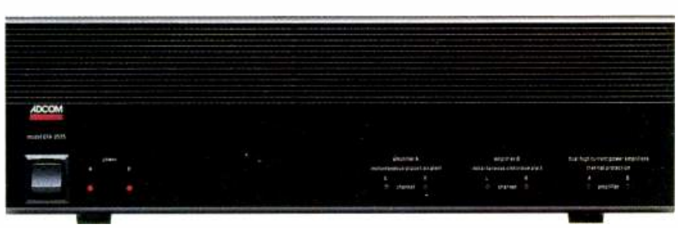
The innovative GFA-2535 is a worthy new standard-bearer. The GFA-2535 is really two GFA-535's in one case, with the flexibility to drive three *or* four channels. With individual level controls for precise control of each amp's volume, it's the ideal foundation for an authentic, ultra-realistic surround-sound theater system, or for a multi-room or multi-speaker audio system.

The Versatility of 3 Channels or 4.

A single switch on the GFA-2535's rear panel lets you select 4-channel operation, or bridge two of the channels for a 3-channel configuration. In the 3-channel mode, the GFA-2535 brings your home theater to life, delivering 200 watts of clean, distortion-free sound to the center channel, and 60 watts to each of the rear channels. Add it to your existing 2-channel amp, and you'll be at the center of a superbly balanced, awesomely powered stage with sound so real, you can practically touch it.

For audio applications, the GFA-2535 in the 4-channel mode acts as a pair of 60 watts-per-channel amps to drive two sets of speakers. With two of the channels bridged, it delivers 60 watts each to a pair of satellites, and 200 watts to a single subwoofer for an incredible display of musical strength so real, you definitely can feel it.

Three channels or four...home theater, home audio...the award-winning Adcom GFA-2535 gives you twice the versatility of ordinary amplifiers...and twice the value that has made Adcom famous.



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"second-order quasi-Bessel bass alignment." The alignment apparently tunes the box's Helmholtz resonance frequency significantly lower than conventional vented enclosures do. This serves to improve low-frequency power handling and response, while allowing a gradual roll-off, and is said

DAHLQUIST'S SPECIAL ALIGNMENT IMPROVES POWER HANDLING AND TIGHTENS THE BASS.

to provide a tighter response than traditional vented or sealed systems do.

The DQ-30i's woofer enclosure is divided into two interior chambers; several large holes in the separating partition allow sound to pass between them. The chamber behind the woofer is completely stuffed with fiberglass and foam absorption materials. The second chamber, which contains the vent, contains no absorption material at all.

The mid and high drivers are sourced from Vifa of Denmark, while the bass driver is supplied by an American manufacturer. All are customed manufactured to Dahlquist's specifications. The long-throw bass driver has an extremely rigid cone and employs Kevlar/cellulose composites said to give the cone material an unusually high stiffness-to-mass ratio.

The 5-inch midrange driver employs poly/carbon fiber composites and hardened polypropylene materials to resist flexure and improve response. The tweeter, ⅞ inch in diameter, incorporates an aluminum-alloy dome, described by Dahlquist as being "dead soft." The high internal damping of the dome is said to move spurious resonances up to inaudible frequencies. The dome is supported by a soft, long-throw, butyl rubber surround that Dahlquist claims enables a longer excursion on powerful transients and greater dynamic range.

Dahlquist says that their Phased Array Technology "places each driver at an optimal position to compensate for its size and reaction time, so that sound from each driver arrives at the listeners at precisely the same time." The company states that "your ears receive a unified wavefront which provides all musical components simultaneously," and thus "sonic realism is dramatically increased."

The crossover of the DQ-30i contains 19 parts, not counting paralleled units. These include six inductors, seven capacitors, and six resistors. All parts are sorted by Dahlquist for close matching. Iron-lamination and air-core coils are used, as are Mylar, polypropylene, and nonpolarized electrolytic capacitors. Electrical slopes are either 12 or 18 dB per octave, and impedance-compensating networks are used generously. The mid/high and the woofer sections of the crossover are connected separately to the rear of the loudspeaker, for possible bi-wiring. Large-diameter stranded wire is employed throughout.

The rear connection panel has two sets of hefty double-banana terminals, connected by gold-plated straps that can be removed for bi-wired operation. The binding posts have hexagonal tops that accept a half-inch nut driver for secure tightening; I wish more systems had this feature.

Measurements

Figure 1 displays the DQ-30i's tenth-octave-smoothed on-axis frequency response. Measurements were taken at a distance of 1 meter from the tweeter, on the tweeter's axis, with 2.83 V rms applied. The response below 400 Hz was derived from in-room and near-field measurements. (I made these tests when 16 inches of snow were on the ground and the temperature was 10° F. Such conditions did not allow convenient outdoor measurements!)

The response is quite smooth and exhibits no significant peaks or dips, but it does show a slight, broad rise between 200 Hz and 3 kHz. The overall curve fits within a fairly tight response window of 5.5 dB from 40 Hz to 20 kHz, with the level at 1 kHz just touching the high edge of the window. The grille causes a fairly major effect on the response above 5 kHz: It reduces the response between 5 and 10 kHz and between 15 and 20 kHz, and increases the response at 12 kHz. Above 20 kHz (not shown), the supersonic response exhibited a sharp dip at 23.6 kHz, followed by a sharp peak at 25.8 kHz—both presumably due to dome breakup.

Averaged from 250 Hz to 4 kHz, the DQ-30i's sensitivity measures 87.4 dB,

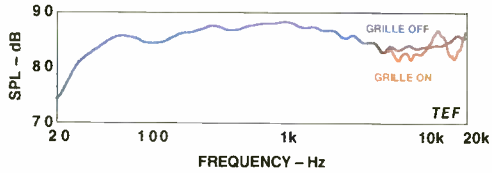

Fig. 1—On-axis frequency response.

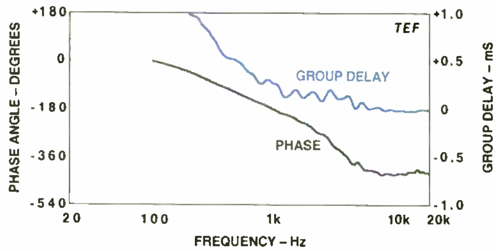

Fig. 2—Phase response and group delay.

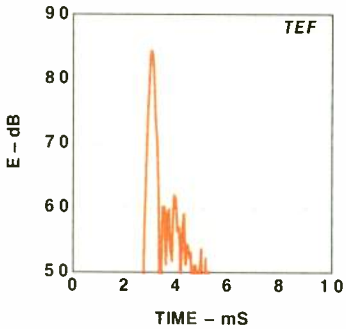

Fig. 3—Energy/time response.

somewhat lower than Dahlquist's 89-dB rating. Right/left matching was a fairly close ± 1.0 dB from 100 Hz to 20 kHz. The main deviation occurred above 3.5 kHz, where one system's tweeter was about 1 dB below that of the opposite system.

Figure 2 shows the phase and group-delay responses of the DQ-30i, referenced to the tweeter's arrival time. Both curves are fairly smooth and well behaved. Between 1


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and 20 kHz, the phase response rotates a significant 240°. This rotation is due to a combination of crossover design and the offset between the acoustic centers of the midrange and tweeter. Between 1 and 4 kHz, the midrange's output lags the tweeter's by about 0.14 mS. Apparently, even though Dahlquist claims the DQ-30i is closely aligned in time because of its Phased Array Technology, the alignment is not as close as advertised.

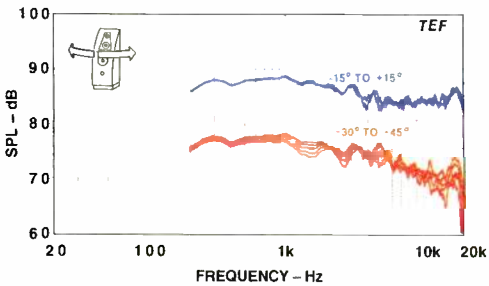

Fig. 4—Horizontal off-axis responses; see text.

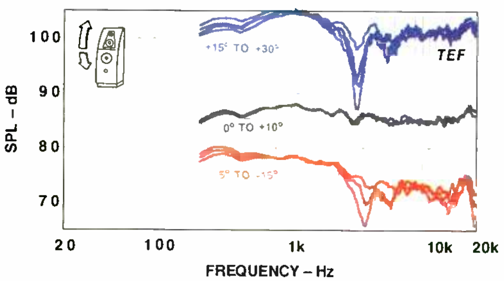

Fig. 5—Vertical off-axis responses; see text.

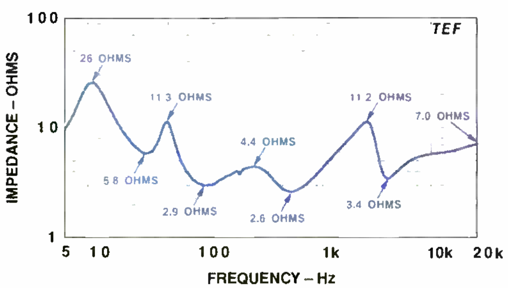

Fig. 6—Impedance.

The DQ-30i's energy/time response is shown in Fig. 3. The test parameters were chosen to accentuate the response from 1 to 10 kHz, which includes the upper crossover. The main spike, at 3 mS, is very compact and narrow; this indicates close, coherent summing of the midrange and tweeter outputs. All delayed responses were at least 22 dB down from the main peak. The tight peak of the curve is actually in some disagreement with the previous data for group delay. Dahlquist does mention in their literature that they use a process called Envelope Alignment to attain optimum driver positioning.

Because I was not able to make my usual 2-meter polar responses outside, I was forced to make what measurements I could in my listening room. I was able to gather an acceptable set of horizontal polar curves at 1 meter but not a set of vertical polar curves. For the vertical responses, rather than mounting the DQ-30i on its side and rotating it to gather data, I moved the test microphone vertically in an arc, at a constant 1-meter distance from the tweeter, and gathered data at 5° intervals from –15° to +45°. Because of the incomplete vertical data, both sets of off-axis response curves are presented in a composite format rather than in my usual "3-D" format.

Figure 4 shows the composite horizontal off-axis responses, without smoothing. The very close grouping in the top set of curves indicates excellent coverage in the ± 15° primary listening window. The range covered in the bottom set of curves is from –45° to –30° and from +30° to +45°, in 5° increments. This set of curves is also quite closely grouped but exhibits some high-frequency roll-off above 7 kHz.

The composite vertical off-axis responses, again without smoothing, are shown in Fig. 5. The middle set of curves shows the responses from 0° to 10° above the tweeter's axis. The very close grouping indicates excellent vertical coverage in the primary, sitting-to-standing, listening window. The top set shows a composite of the responses from 15° to 30° above the tweeter's axis. These curves are also quite closely grouped except for interference in the 3-kHz crossover region, which causes severe dips in the response. The bottom set shows the responses in the range of 5° to 15° below the tweeter's axis. This set is also closely grouped except for some interference in the crossover region and above it. Fortunately, the smoothest vertical response is exhibited in the primary listening range of 0° to 10° above the tweeter's axis.

All the previous off-axis curves were taken on the DQ-30i's tweeter axis. It is noted, however, that the tweeter is actually mounted quite high in the system, about

OVERALL SOUND WAS WELL BALANCED AND WIDE-RANGE, WITH EXTENDED BASS AND VERY GOOD IMAGING.

42½ inches above the floor. A typical seated listener can therefore expect some roughness in the upper midrange, because his ears are likely about 36 to 38 inches above the floor, which is about 3.1° below the tweeter's axis.

Figure 6 displays the impedance of the DQ-30i over the extended range from 5 Hz to 20 kHz. A minimum impedance of 2.6 ohms occurs at 460 Hz and a maximum of 26 ohms at the subsonic frequency of 9 Hz. Above 20 Hz, a maximum of 11.3 ohms occurs at 40 Hz. Similarly low impedance minimums occur at 80 Hz (2.9 ohms) and 3.1 kHz (3.4 ohms). The lowest frequency corresponding to an impedance minimum (in this case, 27 Hz, where the impedance drops to 5.8 ohms) is often considered the vented-box tuning frequency, where the enclosure's resonant loading is at its maximum. I prefer to consider the tuning frequency as being the minimum excursion point, which is measured at high drive levels; for the DQ-30i, this occurs at about 33 Hz. (Normally, these two tuning frequencies are closer together, but I don't know what significance, if any, to attach to that.) The system's multiple low-impedance points at low frequencies show that it will be a fairly demanding load for power amplifiers.

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Within the passband from 20 Hz to 20 kHz, the max/min variation is about 4.3 to 1 (11.3 divided by 2.6), which means that the Dahlquist will be somewhat sensitive to cable resistance. This resistance should therefore be limited to a maximum of about 50 milliohms to keep cable-drop effects from causing response peaks and dips greater than 0.1 dB. For a typical run of about 10 feet, low-inductance cable of 14-gauge or larger diameter should be used.

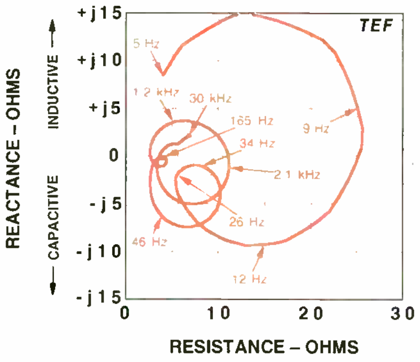

Fig. 7—Complex impedance.

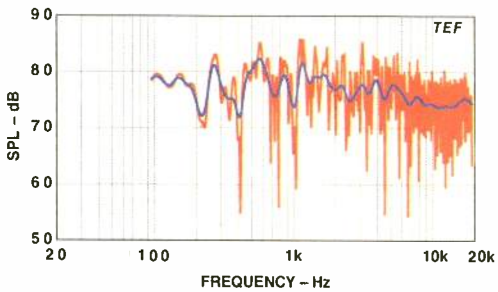

Fig. 8—Three-meter room response.

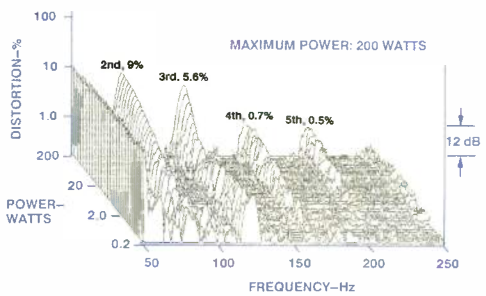

Fig. 9—Harmonic distortion for E_1 (41.2 Hz).

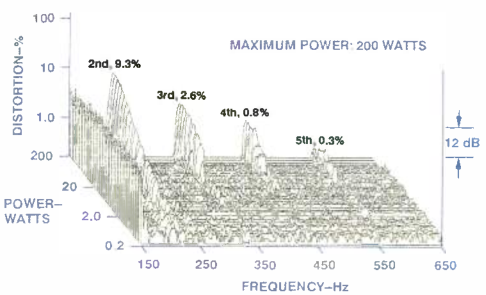

Fig. 10—Harmonic distortion for A_2 (110 Hz).

Figure 7 shows the DQ-30i's complex impedance, plotted over the range from 5 Hz to 30 kHz. It is well behaved. The impedance phase within the passband (not shown) reached a maximum angle of +39° (inductive) at 975 Hz and a minimum angle of –59° (capacitive) at 48 Hz.

On a high-level low-frequency sine-wave sweep, no significant cabinet resonances of the woofer enclosure were evident. However, in the range from 160 to 185 Hz, the side and rear metal screens vibrated badly, generating an objectionable sound. This buzzing occurred at levels above about 1 V rms. A close look at the impedance curves of Figs. 6 and 7 reveals that the screen resonance shows up there as well, in the form of slight aberrations at about 170 Hz.

By covering the port, I determined that it normally reduces the woofer's excursion over a wide frequency range, from 19 to 42 Hz, with minimum excursion occurring at 33 Hz. As noted previously, the minimum excursion at high drive levels (which, in general, indicates the frequency of box resonance) occurred at a significantly higher frequency than the impedance minimum (which is measured at low drive levels). At the 33-Hz box tuning, the excursion was about 40% less than it was when I closed off the port.

With power levels of 100 watts and below (about 20 V rms), at frequencies at and near box resonance (between 25 and 35 Hz, where port air velocity is maximum), vent noise and air turbulence were very low. The DQ-30i sounded quite clean and effortless at all bass frequencies above 20 Hz. The maximum excursion of the 10-inch woofer was a very generous 0.8 inch, peak to peak, with a linear excursion of about 0.6 inch, peak to peak. The woofer overloaded very gracefully but did exhibit some dynamic-offset problems, which made the speaker's center of vibration change with different bass frequencies.

The DQ-30i's 3-meter room response is shown in Fig. 8 with both raw and sixth-octave smoothed curves. The speaker was in the right-hand stereo position, aimed at the listening position, and the test microphone was at ear height (38 inches), at the listener's position on the sofa. The system was driven with a swept sine-wave signal of 2.83 V rms (corresponding to 2 watts into the rated 4-ohm load). The direct sound and 13 mS of the room's reverberation are included. Overall, the averaged curve fits a fairly tight window of 10 dB (± 5 dB) from 100 Hz to 20 kHz, even including the floor-bounce region from 300 to 600 Hz. The general trend of the response is fairly flat.

The single-frequency harmonic distortion spectra versus power for the musical notes E_1 (41.2 Hz) and A_2 (110 Hz) are shown in Figs. 9 and 10. The results for A_4 (440 Hz) are not shown, because the distortion levels were below 1% and consisted of only second and third harmonics. (Side note: The first system I tested for A_4 distortion developed a buzzing midrange. I subsequently made a retest after replacing the bad midrange with a new driver sent from the factory.) The power levels were computed using the Dahlquist's rated impedance of 4 ohms. A maximum level of 200 watts (28.3 V rms) was set as the upper power limit.

THE DQ-30i EXHIBITED EXCELLENT REALISM AND A VERY DETAILED, LIVE, AND CLEAN SOUND.

The E_1 (41.2-Hz) data of Fig. 9 shows that at maximum power the distortion reaches a moderate 9.0% second harmonic and 5.6% third harmonic. The fourth and higher harmonics were all less than 0.8%. At 200 watts, the system generated a loud 106 dB SPL at 1 meter with a 41.2-Hz signal applied.

The A_2 (110-Hz) data of Fig. 10 also indicates a moderate 9.3% second harmonic and a lower, 2.6%, third harmonic. The fourth and higher harmonics were all less than 0.8%. At 200 watts, the DQ-30i gener-

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Hyper-(hi´pər) || <Gr *hyper* || *prefix* over, above, beyond, surpassing

Balance(d) (bal´əns) || <LL *bilanx* ||
1 general harmony between the parts of anything, springing from the observance of just proportion and relationship; esp. in the Arts of Design
2 stability or steadiness due to the equilibrium prevailing between all the forces of any system

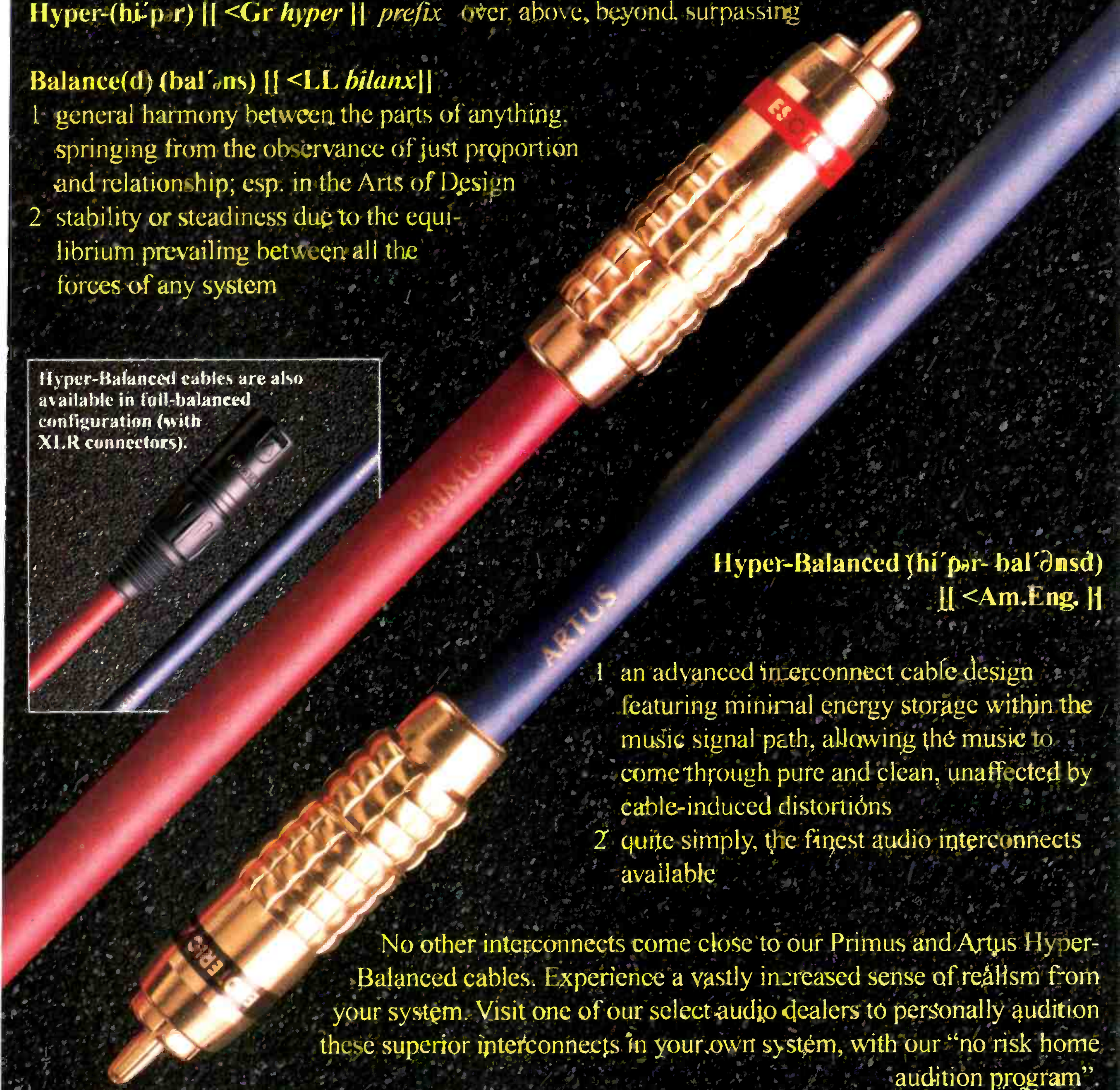

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Figure 11 displays the IM distortion created by tones of 440 Hz (A_4) and 41.2 Hz (E_1) of equal input power. The IM rises only to the low level of 4.2% at 100 watts (the maximum power level I used for this test, in order not to overdrive the midrange). The distortion is relatively low because the speaker's lower (280-Hz) crossover separates the two IM test tones, thus minimizing the distortion.

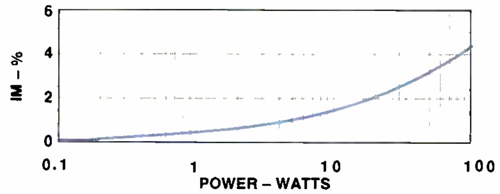


Fig. 11—IM distortion for 440 Hz (A_4) and 41.2 Hz (E_1).

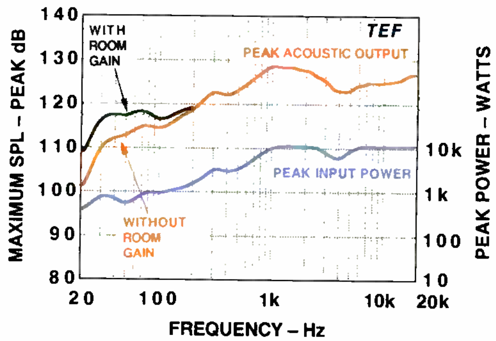


Fig. 12—Maximum peak input power and sound output.

Figure 12 shows the short-term peak-power input and output capabilities of the DQ-30i, as a function of frequency, measured using a 6.5-cycle tone burst with a third-octave bandwidth. The peak input power was calculated by assuming that the measured peak voltage was applied to the rated 4-ohm impedance.

The peak input power starts out quite high, about 325 watts at 20 Hz, rises to a maximum of 800 watts at 31 Hz, falls somewhat to 500 watts at 50 Hz, and then rises thereafter, reaching 11 kW (210 V, peak) above 1 kHz. A reduction at 4 kHz is noted at the low end of the tweeter's range, caused by the test amplifier running out of steam rather than any limitation of the speaker. Between 125 and 630 Hz, the speaker and my test amplifier reached their limits at about the same point, due to the speaker's low impedance through this range.

The top curves in Fig. 12 show the maximum peak sound pressure levels the Dahlquist can generate, at a distance of 1 meter on axis, for the input levels shown in the bottom curve. Also shown is the "room gain" of a typical listening room at low frequencies, which adds about 3 dB to the response at 80 Hz and 9 dB at 20 Hz.

With room gain, the peak output starts very strong, at 110 dB at 20 Hz, rises rapidly to a plateau of about 117 dB between 30 and 150 Hz, and then rises to a maximum of about 128 dB at 1 kHz! The maximum output then falls somewhat, thereafter continuing quite strong to 20 kHz. The DQ-30i can easily create the peak SPLs of live music in a typical listening room if you use an amplifier of appropriately high peak power capabilities. With room gain, the speaker's maximum output exceeds 110 dB above 20 Hz and 120 dB above 220 Hz. The low-frequency maximum output of the Dahlquist ranks it with the best speakers I have tested! A stereo pair will reach even higher low-frequency levels with bass material common to both channels.

Use and Listening Tests

With its curved swept-back appearance, the DQ-30i has a very distinctive, contemporary look that is not soon forgotten. It's a major departure from the pedestrian boxy look that is typical of most loudspeakers. The same fresh look is carried through the whole DQ line; unusual styling has been associated with the Dahlquist name from the start.

My review samples were supplied in black trim, and all exposed surfaces were black. The fit and workmanship were very good. The whole cabinet assembly felt quite strong and solid, with the exception of the metal coverings on the top part of the system. The grille does not look removable, but it's actually easy to take off: Just stick your fingers under its outside edge, and pull. Once removed from the system, the grille is limp and floppy. Jeff Hammerstrom, the speaker's designer, suggested that I might want to do my serious listening with the grilles removed, which I did.

Each DQ-30i is supplied with three large, cone-shaped feet attached to the bottom of the bass enclosure. These feet, which are about 3 inches in diameter, come to a sharp point at a 45° angle. A set of optional cone feet was later supplied to me; these feet had 1¼-inch spikes added to the points of the cones, for better penetration of carpets. I only had time to experiment by replacing just one system's feet with the optional spikes. With them, the cabinet was much more solidly connected to the floor. On my carpeted floor, the optional feet raised the speaker about 1 inch higher than the stock feet. This was a disadvantage, because the DQ-30i's optimum vertical listening axis is already significantly higher than that of most other loudspeakers.

Because the Dahlquist's center of gravity is located towards the front of the cabinet, it took significantly less force to tip the DQ-30i forward than back. I would suggest keeping toddlers and young children away from the rear of the speakers, so they can't accidentally tip the Dahlquists over.

The 13-page owner's manual for the DQ series is extremely well done. It offers good suggestions and guidance in many areas, including choice of speaker wire and connections, bi-wiring, room acoustics and potential problems, and speaker placement. Dahlquist suggests placing the systems as far away from your room's side and rear walls as is practical and toeing them in towards the listener. They suggest following the "rule of thirds," placing the speakers and listeners each one-third of the room's length from the end walls, with each speaker a third of the room's width in from the sides.

I placed the DQ-30i speakers in my usual listening positions, which were in close agreement with Dahlquist's recommendations. This placed the speakers about 8 feet apart, 10 feet from my sofa, and about 5 feet from the wall behind them. My listening equipment includes a newly acquired Krell preamplifier and power amplifier

along with Rotel and Onkyo CD players. My reference speakers are the B & W 801 Matrix Series III units (the Series III recently replaced the Series II, which had been my reference from the start). All cabling is from Straight Wire. Listening was done with the Dahlquists' grilles off.

Initial listening disclosed a well-balanced, wide-range sound with extended low-frequency capability and the ability to do justice to many different types of program material. The Dahlquists' imaging capabilities were very good. Their sensitivity was quite close to that of the B & W systems, so no level adjustment was required when switching between speakers.

On the very revealing third-octave band-limited noise signal, the DQ-30is kept up with my B & W systems over most of the low-frequency bands in terms of sheer bass output. However, the B & Ws were somewhat cleaner than the Dahlquists due to lower levels of vent noise. At most bands, the port noise of the Dahlquist systems included a slight but audible whistle-like sound. At the 63- and 80-Hz bands, significant outward cone displacement was evident due to dynamic offset problems. (The easiest way to distinguish dynamic-offset displacement from genuine program-generated displacement is to reverse the leads going to the speaker and note if the direction of the displacement changes. If the direction does not change, it is self-generated dynamic displacement.) In addition, at the 125- and 160-Hz noise bands, highly audible vibration of the top and rear screens was evident. I searched for program material that would cause audible sounds from these screens but did not have much success. The only music that consistently set them off was pipe organ. Fortunately, the energy content of program material must be highly concentrated in the screen's resonance range and be of high level to set off the vibration. Any additional program content in other frequency ranges often masks the vibration's sound.

The sound of pink noise did not change much as I went from sitting down to standing. However, most of the change was heard when I sat, making the Dahlquists sound slightly muffled. This is because the DQ-30i's tweeter is about 42½ inches from the floor, about 6½ inches above my ears when I was sitting on my sofa. That placed my ears about 3.1° below the tweeter's axis. Hammerstrom, the designer, told me that sitting in his favorite listening chair places his ears about 43 inches above the floor, hence his reliance on a higher listening axis. I can't recommend tilting the Dahlquist forward to remedy this, because of the previously mentioned balance problem. My quick fix was to sit on a large overstuffed pillow; another solution might be to remove the cone bases, which would lower the DQ-30i by about 3½ to 4 inches. (As mentioned, the optional base with spikes only makes the tweeter higher.)

The Dahlquists exhibited excellent realism and a very detailed, live, and clean sound on a recording of music from the Renaissance period, *Songs of the Sephardim: Traditional Music of the Spanish Jews* by La Rondinella (Dorian Discovery DIS-80105). They also did very well on quite different music that is normally played quite loud. When I was recently in Berlin to attend an Audio Engineering Society convention, I picked up a German compilation of extended-mix dance versions of club music. The DQ-30is could play loud and clean, with solid low end, on this CD, *Maxi Dance Sensation 8* (BMG/Ariola 74321 11562). The reproduction of horns and the orchestral soundstage of Liszt's "Les Préludes" (you probably know this piece, the old Flash Gordon theme music) were very impressive. The Liszt selection came from *Ravel: Boléro* (Music Digital 31 003, one of Delta Music's inexpensive but high-quality "DDD" classical import compilations; I picked it up at a local supermarket for $2.99.)

Program material permitting, the DQ-30i's soundstage capabilities and stereo focus were always very good. On mono signals, the stability and narrowness of the center image was excellent. The Dahlquists' extended bass response provided a solid underpinning for pipe organ music; they could essentially keep up with my reference B & W 801 Matrix Series IIIs on bass pedal notes.

In summary, the DQ-30i's many virtues well exceed its weaknesses. Its fine imaging capability, smoothness, neutrality, and extended bass response—coupled with its refreshing styling—make for a solid contender in the $2,000-per-pair range.

D. B. Keele, Jr.

Metaxas, *continued from page 66*
power amp included the following: An Oracle turntable fitted with a Well Tempered Arm and Spectral Audio MCR-1 Select moving-coil cartridge, a Krell Digital MD-1 CD transport feeding a PS Audio UltraLink or Counterpoint DA10 D/A converter, a Nakamichi 250 cassette recorder and an ST-7 tuner, and a Technics 1500 open-reel recorder. Preamplifiers used included a Counterpoint SA-5000 and First Sound Reference II. Other power amplifiers used were a Crown Macro Reference and a pair of Quicksilver M135 mono tube prototypes. Loudspeakers used were Win Research SM-10 monitors, early Genesis Technologies two-way prototypes, and Scientific Fidelity Joules.

THE SOLITAIRE OFFERS GREAT TRANSPARENCY AND EXQUISITE SPATIAL PRESENTATION.

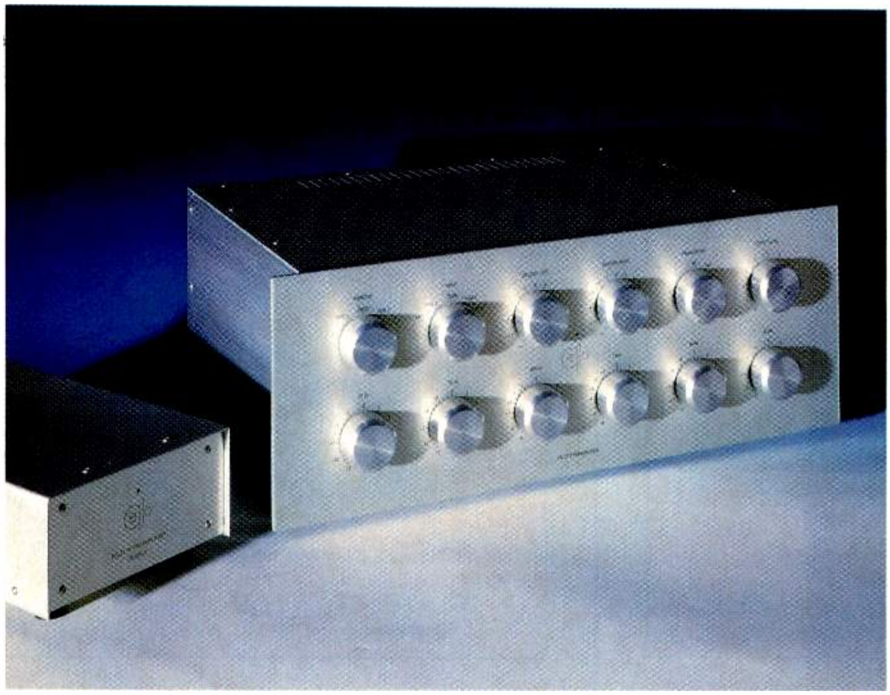
The Solitaire is yet another solid-state amplifier that I liked from the first time I heard it in my system. It passed very musical and unharsh sounds through to the speakers. Its sound is characterized by exquisite spatial presentation, solid dynamics, great transparency, and a tonality that is a little soft-sounding in the high frequencies. This amp is lyrical and quick sounding. Some of my favorite software that might be a bit edgy on other otherwise good amps sounded smooth and less irritating on the Solitaire yet had great definition.

I had two nit-picks about the Solitaire: It made a very audible pop some 5 or 10 S after the power switch was turned off, and the hum in the right channel was definitely audible at the loudspeaker and just discernible at the listening position when no signal was going through the system. In practice, however, this hum level is not going to be a problem except with very efficient loudspeakers; it didn't really bother me.

Overall, though, I enjoyed having the Metaxas Solitaire in my system, and listened to a lot of music through it. I forgive its trivial technical flaws for its wonderful music transference. A BHK thumbs-up for this one.

Bascom H. King

CELLO PALETTE PREAMPLIFIER



The most interesting high-end products are those that challenge our preconceptions about what constitutes an audio component, and the Cello Palette preamplifier is an excellent case in point. For nearly two decades, high-end preamps have evolved toward presenting the least possible interference to the signal path. In the process, they have lost tone controls, filters, gain stages, capacitors in the signal path, balance controls, and anything else that their designers felt might affect the sound. The result is that most of today's high-end preamps are little more than expensive switch boxes with impedance matching and gain.

In contrast, the $6,500 Cello Palette preamplifier is a line-level preamp with six frequency adjustment controls that allow the user maximum flexibility in compensating for problems in a recording, a front-end device, the loudspeaker system, and/or the listening room. The six controls cover the low bass (±22 dB at 20 Hz), mid-bass (±12 dB at 120 Hz), lower midrange (±6 dB at 500 Hz), middle midrange (±6 dB at 2 kHz), upper midrange/lower treble (±12 dB at 5 kHz), and upper treble (±22 dB at 20 kHz.) There is little point in buying the Cello Pallette if you do not intend to use these controls—and use them actively.

Many cheaper high-end preamps offer comparable switching and gain features, and about the same degree of sonic neutrality, when used purely as flat-response line-stage preamps. In the past few months, I have tested such products from Audio Research, Classé Audio, and Krell. At the same time, I know of no other high-end preamp that can provide anything like the equalization capabilities of the Cello Palette with anything like the same degree of transparency. And while it is easy to find preamps with more equalization controls or even with a complex mix of parametric equalization and digital signal processing, all such units I have tested to date fail to approach the Cello's sonic purity. Indeed, they introduce an audible note of haze, harshness, and midrange coloration to the sound, and that haze grows in direct proportion to the amount of equalization employed. They are fascinating as audio toys, but their ability to adjust frequency is more than offset by the damage they do to imaging, low-level information, harmonic detail, reproduction of the soundstage, and the many other nuances that communicate the true quality of the performance and the recording. The result is listening fatigue and annoyance. Inevitably, one finds oneself using less and less equalization, to the point where a preamp without such abilities is far more preferable. In contrast, the Cello restores a sense of adventure to the high-end listening experience. The range and frequency of its controls seem uniquely well chosen for dealing with the challenges of high-quality recordings and high-end sound systems in a real-world listening environment.

For example, with my Thiel CS5 reference loudspeakers, I used the

Company Address: 315 Peck St., Bldg. 23, New Haven, Conn. 06513.
For literature, circle No. 92

20-Hz control to substantially boost the deep bass of many recordings by 3 to 6 dB and to compensate for specific bass problems that Mark Levinson of Cello said exist in several recordings. There was no question that a substantial amount of equalization helped a great many recordings. A major boost often restored the feelings of concert-hall power, depth, and emotional life missing from most conventional symphony, jazz, and organ recordings and from the few rock recordings that have measurable deep bass. A major cut salvaged many popular recordings, particularly jazz recordings on the Atlantic label.

The 120-Hz control proved useful with most jazz and rock. A cut of 2 to 6 dB often opened up the entire performance, getting rid of the mid-bass hangover and coloration found in the recordings of all too many mainstream producers. A major cut in this region, and a boost of the 2- or 5-kHz control, often made the lyrics of many rock CDs intelligible for the first time.

Some daring is required in using those 2- and 5-kHz controls, as well as the 500-Hz control. Many recordings require little or no change. On the other hand, judicious cuts can often partially compensate for the "in your face" close miking of many recent recordings, yielding a more realistic sense of distance and delicacy. A substantial boost can compensate for the eccentricities of the treble roll-off in Glenn Gould's 1981 recording of the Goldberg Variations (CBS MK-37779) as well as for some hall effects with choral and opera recordings that treat the upper range of voices as a needless luxury. The 500-Hz control is particularly useful in adjusting the warmth of strings and woodwinds, the 2-kHz control in restoring natural timbre to both voice and instruments, and the 5-kHz control in setting the apparent timbre of the upper octaves.

At first, I was extremely reluctant to make any serious use of the 20-kHz control. Cello correctly states that equalization in this area has a surprising effect on the apparent space and air of good recordings. At the same time, my past experience with equalizers had indicated that significant boost produced substantial long-term listening fatigue. Within my family, reactions to high-frequency boost differ markedly according to the listener's age and sex, reflecting the superior upper-octave hearing of women and younger men. It is a tribute to this preamp that a boost of 3 to 6 dB was clean enough and high enough in frequency to improve the apparent life and space of many, if not most, good recordings without adding "edge" or inducing listener fatigue.

There are a few practical aspects of the Cello Palette preamplifier that you should be aware of. It has two tape loops (inputs and outputs) and three regular high-end inputs. It can power a separate moving-coil or moving-magnet phono preamp. Rather than a single balance control, it has separate right and left level controls, providing an easier way of setting balance precisely, particularly when you use high degrees of equalization. Some more conventional controls, like a muting or absolute-polarity switch, are absent. There are no balanced inputs, and the use of specialized Fischer balanced output connectors (in addition to regular RCA unbalanced outputs) may lead to compatibility problems for some cable fanatics not using Cello cables and power amplifiers.

More important, this is a big unit—16½ inches x 6¼ inches x 12 inches—with a separate power supply. I constantly found myself wishing I could place the Cello within reach of my listening positions; if I were to buy this unit for permanent installation, I would want it where I could rapidly fine-tune it for a given band on a given recording. Its high input impedance and high output levels do allow you to use long interconnects, but this is not a compact little box, and you should carefully consider custom installation.

A few general caveats are also in order. The Cello is not designed to compensate for a poor high-end system, an inadequate listening room, or noisy recordings. I have read claims from other manufacturers over the years that their equalizers could provide such compensation. In my opinion, these claims are absolute nonsense.

Even a third-octave equalizer cannot compensate for record or tape noise without an audible loss of musical information. Years of playing around with devices designed to remove record pops and tape hiss have convinced me that the disease is better than the "cure" provided by any consumer device.

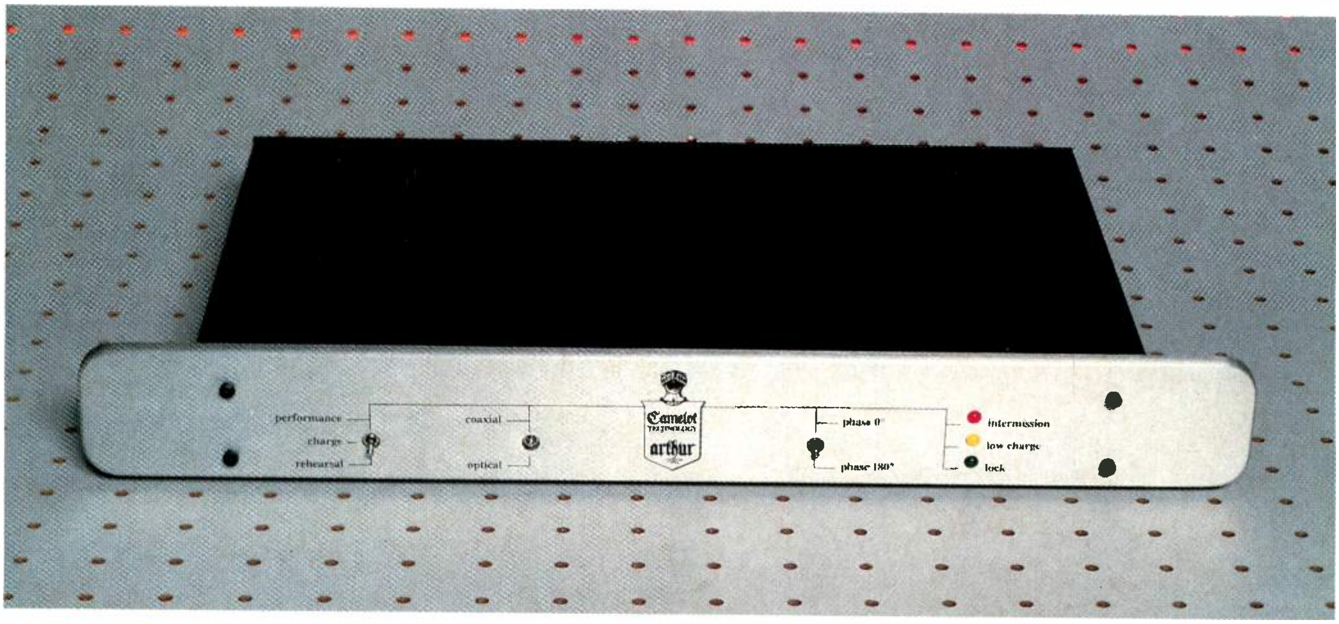
A speaker without deep bass and extreme power handling capability cannot take the equalization required in the bass, and I have found that speaker/room interaction requires at least third-octave equalization in the low to mid-bass—something that usually only highly specialized or professional EQs can provide. Furthermore, only dedicated equalizers can smooth speaker response at higher frequencies and compensate for the crossover-induced problems common in low- and medium-cost designs. No equalizer I know of can compensate for phase, time, and distortion problems at any frequency (which are usually made worse in most speaker systems by power handling problems with one or more drivers when high levels of equalization are applied).

THE CELLO PALETTE RESTORES ADVENTURE TO THE HIGH-END LISTENING EXPERIENCE.

In real-world listening rooms, perceived timbre and transparency are very much dictated by reflected sound. Further, high levels of equalization make me more aware of radically different frequency response with comparatively small changes in listening position. Similarly, I am more aware of bass response when the room is excited by standing-wave and other resonance problems if lots of equalization is used.

So the joy provided by the Cello Palette preamplifier comes from re-exploring the capabilities of clean recordings played through a good system in a good room. It is a way of expanding your musical consciousness and pleasure—an aesthetic device, not an electronic crutch! At the same time, it is a truly exciting product, one that can indeed make both your system and your recordings come alive in new ways. If it challenges the conventional wisdom of the high end, then such a challenge may long be overdue, and high-end designers need to rethink both analog and digital preamplifier design to see if they can provide equal or superior equalization and signal processing capabilities with equal transparency. *Anthony H. Cordesman*

CAMELOT TECHNOLOGY ARTHUR D/A CONVERTER



Arthur comes with Excalibur, a digital interconnect.

Camelot Technology's Arthur is a very unusual D/A converter in that it is designed to be powered by batteries! The idea behind this, of course, is that batteries provide a purer source of d.c. to run the circuits than any power supply that runs off the a.c. line can. To further enhance this purity, there's a "Performance" mode, in which this $1,195 unit's charging circuit is disconnected from its batteries.

This mode is one of three selected by a three-position toggle switch at the far left of the front panel. Below the "Performance" position are positions for "Charge" (for charging what Camelot calls the Guenevere battery power supply) and "Rehearsal" (for operation while charging). The next control is a two-position toggle switch for selecting between coaxial and optical inputs. Absolute polarity can be reversed in the digital domain by the last switch, another two-position toggle.

When the batteries are too low to operate Arthur in "Performance" mode, the unit mutes and a red "Intermission" LED at the far right glows. Below it are a yellow "Low Charge" indicator and a green "Lock" LED that lights when Arthur has locked onto the digital source signal.

On the rear panel are an IEC a.c. power connector, right and left analog-output phono jacks, a place for an optional AT&T glass-fiber optical connector ($250, installed), a Toslink optical input connector, and coaxial connectors for SPDIF input from a CD player and SPDIF buffered recording output. On my sample, these coaxial connectors were BNC types, but newer production runs will have RCA phono jacks instead. Arthur's price includes the Excalibur digital interconnect cable, to provide impedance matching and signal isolation between a CD transport's digital output and the D/A converter's SPDIF signal input.

Also on the rear is a four-pin DIN plug marked "I^2S," an inter-IC sound digital serial data bus output. This industry-standard interface will allow Arthur to be used as a "front-end" to provide switching, data demodulation, and polarity-inversion control for digital signal processors and more advanced D/A converters.

Some of the salient technical features of Arthur's internal circuitry are as follows: The SPDIF coaxial signal input is passed through several C-MOS inverter gates to build up and square up the received input to logic levels of 0 and 5 V. The signal selector switches between the built-up coaxial input or the output of the Toslink (or AT&T, if installed) opti-

Continued on page 88

Company Address: 30 Snowflake Rd., Huntingdon Valley, Pa. 19006.
For literature, circle No. 93

PANAMAX MAX 1000 SURGE PROTECTOR AND LINE CONDITIONER

Not everyone needs a Panamax Max 1000 surge protector and line conditioner, but everyone could use one. It has some really great features that enhance the performance of component audio/video systems.

SPECS

Clamping Level: 200 V.
Peak Suppression: 310 V.
Capacity: 15 amperes.
Line Voltage: 120 V a.c., 50/60 Hz.
Response Time: Less than 1 nS.
Peak Impulse Current: 13,000 amperes.
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Weight: 2½ lbs.
Price: $299.
Company Address: 150 Mitchell Blvd., San Rafael, Cal. 94903; (800) 472-5555.
For literature, circle No. 94

To me, the main advantage of this unit is that it is very effective in filtering out noise that can get into your system from the a.c. power line. The Max 1000 will also protect your valuable audio and video components from damage that can be caused by line surges or even lightning. This protection extends to catastrophic spikes and interference coming down the coaxial cable from your antenna or cable TV system, if that cable is run through the r.f. input and output F-connectors on the Max 1000's rear panel.

The rear panel also carries eight a.c. outlets, which should be enough for the most complex audio/video system. Two outlets are always live, so you can plug in a video recorder, to keep its timer going, and a receiver or preamp that can be used to control power to the rest of the system. To accomplish this, the receiver or preamp is plugged into a live outlet, and a power cord from the Max 1000, marked "Master Control," is connected to a switched a.c. outlet on the receiver or preamp. Once that's done, turning the receiver or preamp on with its remote control will energize the "Master Control" cord; when the Max 1000 senses this, it activates its six switched outlets. Two of those outlets, marked "Delayed Turn On," can be used for power amplifiers, so any startup transients from the other components won't reach your loudspeakers.

Equipment connected to the Max 1000 can also be turned on or off by its front-panel master switch. The panel features a row of 20 red, amber, and green LEDs that show the a.c. line voltage, in 2-V steps, from 90 to 128 V. A separate LED near the master switch indicates that the unit is plugged into a live a.c. power source, even when the master switch is off. There is a delay of about 45 S between the time you plug the heavy-gauge power cord into a live socket and the time that this LED comes on.

The chassis is heavy-gauge steel, painted black with legible white lettering; an accessory rack-mounting kit is available for $15. If you remove the seven cover screws, you will see a circuit board with many components, including six varistors, two

current-sensing inductors, three 15-ampere relays, six transistors, and numerous integrated circuits. A user-resettable circuit breaker is on the rear panel; the Max 1000 also has a large internal fuse. If this fuse ever blows, it is usually due to some catastrophic occurrence, and Panamax would like you to return any Max 1000 with a blown fuse to their service facility so they can inspect the unit and make the necessary repairs. Panamax offers a lifetime warranty on the unit itself and will also pay to repair or replace any equipment that is damaged by a surge passing into it through the Max 1000 protector.

The Max 1000 is far more sophisticated than other power controllers you may have seen or heard about. Its ability to neutralize or suppress r.f. noise particularly impressed me. I confirmed this ability by connecting both an AM receiver and a lightbulb with a dimmer (a common source of r.f. interference) to the Max 1000's outputs; since these outlets are connected in parallel, this effectively bypasses the unit's filtering. With my receiver tuned to stations at the low end of the AM dial, such as 560 and 610 Hz, I adjusted the dimmer control until the noise was unbearable. I then unplugged the bulb and dimmer and plugged them into the outlet from which the Max 1000 was drawing its power. Since the dimmer's noise was then passing through

THE MAX 1000'S LIFETIME WARRANTY COVERS ANY EQUIPMENT THE UNIT FAILS TO PROTECT.

the Panamax unit's filters, the noise became much lower, and the AM station was listenable again. I know that there are many AM stations broadcasting in stereo with very high quality. If audio manufacturers finally offer good AM stereo sections in their tuners and receivers, the Max 1000's r.f. noise reduction could be invaluable. If you consider the cost of all the components in your system, you will likely find that the cost of adding the surge protection and a.c. line-noise reduction offered by the Max 1000 is a small percentage of the total. In any case, I think that the Max 1000 is an excellent device. *Edward M. Long*

Camelot, *continued from page 84*

cal transducer modules. Output of the signal selector then goes into the digital receiver, in this case a Philips SA7274. This receiver chip doesn't have a built-in phase-locked loop for recovering the clock signals, as the more commonly used Yamaha YM3623B and the increasingly used Crystal CS8412 do. An external phase-locked loop

ARTHUR'S SMOOTH AND UNOFFENSIVE SOUND MAKES CDs WITH EDGY SOUND MORE ENJOYABLE.

circuit is tied into the SA7274 for this function. Recovered and reconstituted word clock (which tells the D/A which bits in the serial data stream are for the right or the left channel), master clock, bit clock, and data are then passed on to a Philips SA7323 bitstream D/A converter chip. This converter up-samples and noise-shapes the data into a pair of one-bit data streams at 256 times the standard CD sampling frequency of 44.1 kHz. An onboard switched-capacitor filter network recovers the audio information from these bit streams. Operational amplifiers in this chip are connected together to form a third-order low-pass filter to remove out-of-band sampling components. The filtered audio signal is passed through a final output amplifier to raise the output signal to a greater level than could be accommodated by the SA7323's +5-V supply.

The power-supply scheme used in Arthur provides charge for the two 6-V, sealed lead-acid batteries that are wired in series to make a basic supply of 12 V d.c. When the unit is in its "Charge" or "Rehearsal" mode, the incoming a.c. is stepped down with a power transformer, rectified into d.c., filtered, passed through a charging regulator, and, finally, fed into the batteries. In the "Performance" mode, all of this circuitry is disconnected from the batteries, and they supply all the power. Several +5-V IC regulators decouple and distribute power to the various digital loads. A converter circuit takes the +12 V as an input and creates a –12 V unregulated supply. Then the positive and negative 12-V supplies are regulated down to a lower voltage to run the output op-amps.

Measurements taken on Arthur revealed a very flat frequency response with small ripples in amplitude of approximately 0.1 dB between about 1 and 20 kHz. This and other measurements (such as linearity or distortion versus frequency and level) were typical of the performance of an SA7323 D/A chip.

With all this technology, how does Arthur work and sound? What happens when Arthur is running on batteries and you remove the a.c. line cord to really isolate it from the power line? To evaluate the sonic properties of Arthur, I used my usual reference system. For digital playback, a Krell MD-1 CD transport feeds the D/A in use through coaxial cable. The D/A's output feeds a First Sound Reference II passive preamp via a 2-meter pair of Music and Sound Imports' Masterlink LP cables. Output of the First Sound, through a 1-meter pair of Masterlink LP cables, drives various power amps. Speakers used were Win Research SM-10 monitors and Scientific Fidelity Joules. Other converters used during the review period were my current resident favorite, a PS Audio UltraLink, a Counterpoint DA-18, and a number of experimental designs.

The basic sound of Arthur is smooth and unoffensive. This makes a lot of CDs, which otherwise could sound edgy and irritating, more enjoyable. However, resolution and detail were not as good as with the other converters used. Space and imaging are good, as are the quality and extension of bass. When I used the supplied Excalibur instead of my usual digital interconnect cable, I felt that resolution and space improved noticeably.

I did indeed detect an improvement when switching from Arthur's "Rehearsal" mode (battery plus a.c.) to its "Performance" mode (battery only). A subtle but noticeable improvement occurs when unplugging the a.c. power cord from Arthur. With a fresh charge on the batteries, the unit would play for at least four hours before stopping. However, to be on the safe side and for best sound, I would recommend limiting playing time to about three hours between charges.

I would also recommend Arthur to those whose sonic priorities include smoothness and lack of irritation when listening to Compact Discs. *Bascom H. King*


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VIDEO ACOUSTICS HOME THEATER SPEAKER SYSTEM

Video Acoustics is a new brand of American-made speakers from Thomson, the French electronics giant that also owns RCA and GE consumer electronics. The initial Video Acoustics line consists of four speaker models from which you can form a complete home theater speaker system for about $2,000. These models are the VA 1400 main-channel bookshelf speakers ($599 per pair), the powerful sounding VA 1500 subwoofer ($599), the VA 1300 center-channel speaker ($349), and the VA 1200, a dual-channel surround speaker in a single cabinet ($499). The system I evaluated included a pair of optional tall stands ($249 per pair) on which I mounted the bookshelf speakers; a wall-mounting shelf for the surround speaker costs $149. Both natural and black oak finishes are available.

Company Address: 6225 Running Ridge Rd., Syracuse, N.Y. 13212.
For literature, circle No. 95

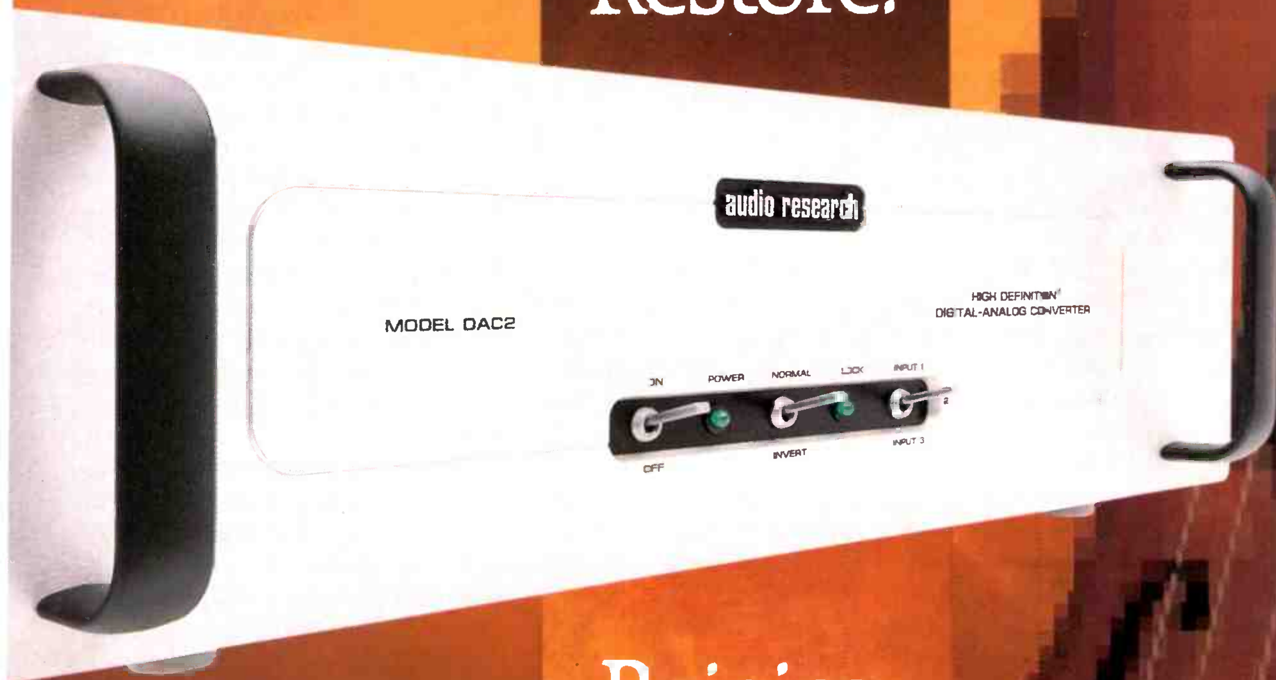
The VA 1300 center-channel system houses a horn-loaded tweeter plus a pair of 5¼-inch mid/woofers in an acoustic-suspension enclosure (only 7$\frac{1}{16}$ inches high, 15½ inches wide, and 7⅛ inches deep) that can be placed unobtrusively on top of a TV. The mid/woofers are angled for wide horizontal dispersion and are aligned in time with the tweeter. This array's frequency response is 100 Hz to 19 kHz, ±4 dB. Sensitivity is rated at 90 dB SPL, and the crossover frequency is set at 3 kHz. Recommended amplifier power is 20 watts minimum, and maximum power handling capacity is 200 watts with program material.

Each of the two VA 1400 bookshelf front-channel speakers features an 8-inch shielded mid/woofer with a 1½-inch voice-coil and a ¾-inch Ferrofluid-cooled, shielded soft-dome tweeter. Response extends from 65 Hz to 17 kHz, ±4 dB, which suggests to me that these speakers are intended for use with a subwoofer. Their sensitivity is 86 dB. Minimum recommended power is 30 watts per channel if the speakers are used alone or 50 watts per channel if the same amplifier is driving a subwoofer; each VA 1400 is rated to handle up to 250 watts of program material. The sealed enclosures measure 15 x 10 inches and are 7$\frac{3}{16}$ inches deep; they may be mounted vertically or horizontally.

The VA 1500 subwoofer's frequency response is rated at 37 to only 72 Hz (±3 dB). Thanks to that low, 72-Hz cutoff, this hefty unit (about 70 pounds, with cabinet walls ¾ inch thick) can be placed just about anywhere in the home theater. Two shielded 8-inch woofers, one per channel, are each housed in separate bass-reflex sub-enclosures. The reflex ports are flared to reduce port noise caused by air turbulence. The subwoofer can handle up to 250 watts of power per channel with music; a minimum of 50 watts per channel is recommended by the manufacturer. Sensitivity is 87 dB SPL. Despite its extended low-fre-

Retrieve.

Restore.



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quency response, the VA 1500 is a relatively small cube, only 19½ inches in each dimension.

Perhaps the most unusual and innovative system of this Video Acoustics home theater group is the surround speaker. The VA 1200 is a single-enclosure system designed specifically for reproduction of Dolby Surround and Dolby Pro-Logic surround tracks. The enclosure houses six transducers, a pair of side-firing 4½-inch woofers and four upwards-firing 3½-inch tweeter/midrange drivers. The VA 1200 has a slightly higher sensitivity (92 dB SPL) than the other models, so that its output will still match that of the other speakers in the system even when it's driven by the low-power surround channels of most A/V receivers. The owner's manual recommends that this dual-channel enclosure be mounted behind the listener and well above the listener's ears to produce an enveloping sound field yet allow appropriate localization. This enclosure should, in fact, be positioned so that listeners are not conscious of its presence. Because this speaker's sound is mainly aimed away from the listener, no specification for on-axis frequency response is given, but overall acoustic power response is rated as 78 Hz to 6.3 kHz, ±6 dB.

The design and engineering of the Video Acoustics system was by RH Lyon Corp., an acoustical design firm in Cambridge, Mass. The firm's founder and president is Richard H. Lyon, a professor of mechanical engineering at MIT, a leader of MIT's acoustics program, and president of the Acoustical Society of America.

I was eager to set up the Video Acoustics speaker elements. I selected the Onkyo TX-SV909PRO receiver to power them, both because it was one of the "winners" in my "A/V Receiver Roundup" (December 1992 issue) and because its front and center channels offer adequate power (110 watts per channel) for the bookshelf/subwoofer combination and the center-channel system while supplying less power (30 watts per channel) to the surround module. (With only five channels of audio required by the Video Acoustics system, the extra, "front effects," outputs of the Onkyo receiver were not used in this setup.)

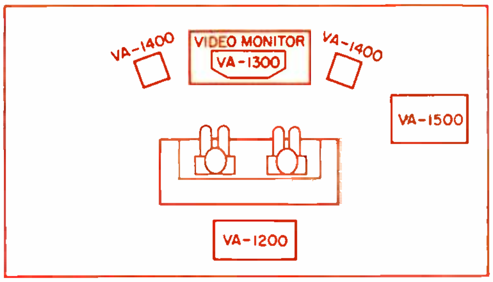


Fig. 1—Speaker placement recommended by Video Acoustics.

The Video Acoustics system manual (supplied in each of the speaker cartons) suggested two ways to hook up the front bookshelf speakers and subwoofer. You can wire one bookshelf speaker and one channel of the subwoofer directly to each amplifier channel, or, since the subwoofer has a second set of terminals, wire the subwoofer to the amplifier and hook the bookshelf speakers to the extra terminals on the subwoofer.

Overall, I tried to adhere as closely as possible to the recommended setup shown in Fig. 1. However, while the room shown is wider than it is long, mine is the opposite, about 20 feet from end to end and 16 feet across. Since my seating position was along the shorter back wall, I put my TV monitor and the bookshelf speakers about 13 feet from my viewing and listening position, rather than placing them along the far wall. My home theater's ceiling is only a little over 7 feet high, and the ceiling is acoustically treated. Its walls are wood-panelled, with no absorbing or diffusing treatment.

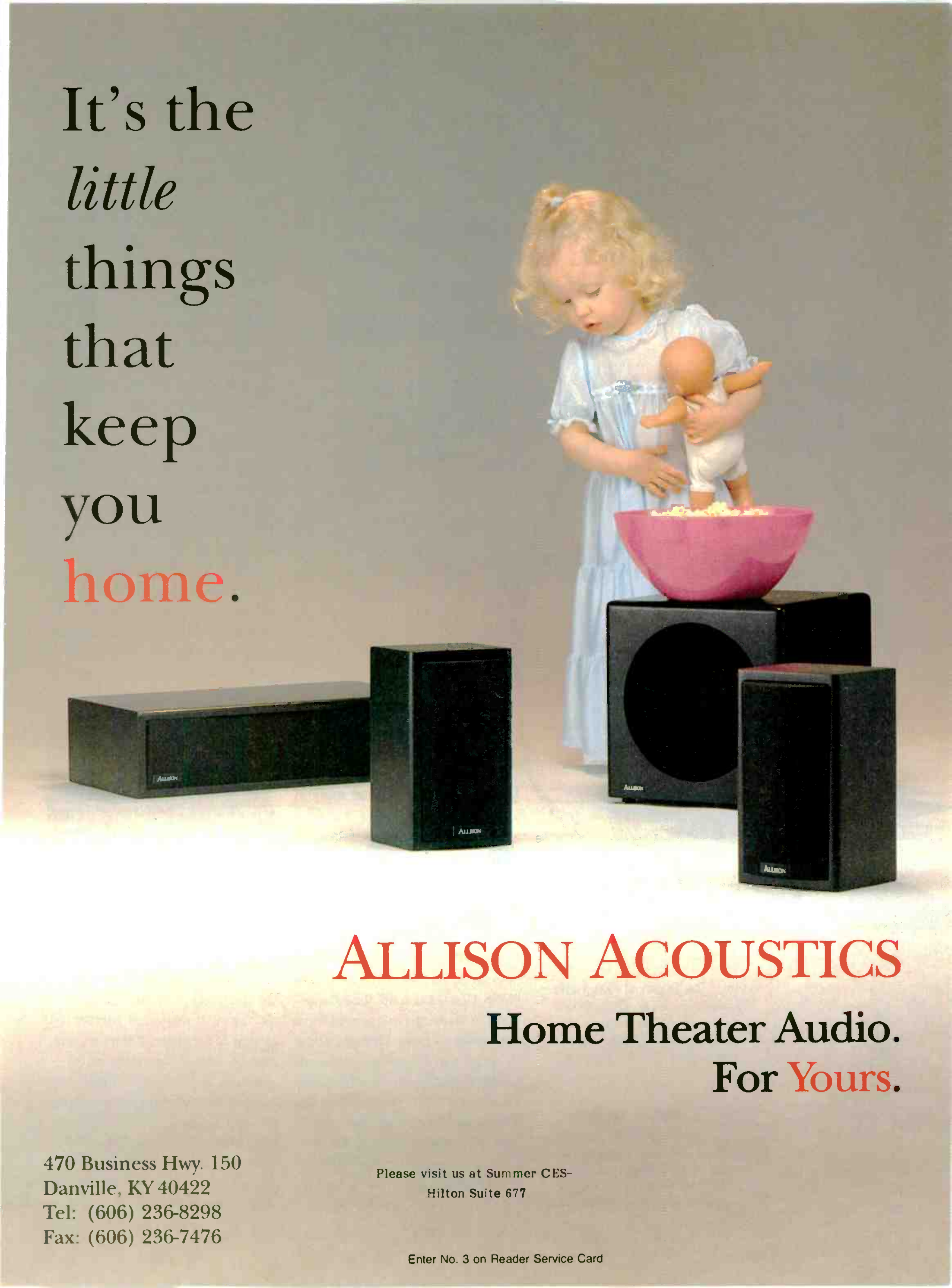
Despite the less than ideal acoustic environment in which I listened to the Video Acoustics system, I was very pleased with the overall theater-like effect. What impressed me most was the ability of the center-channel module to maintain on-screen dialog even when I shifted my position away from the ideal "sweet spot." So long as I didn't stand up, the surround speaker provided the same image stability, even when I moved from one end of my 7-foot couch to the other. Whether by luck or because of the design of the surround module, the objective of not being conscious of that speaker's location was successfully realized, and effects such as airplane flybys (from front to back) and gunshots in battle scenes seemed as real as they do when I see movies in a theater with proper Dolby Stereo equipment.

For the most part, I watched stereo broadcast and cable TV programs rather than laser videodiscs. My 32-inch TV monitor fed stereo signals to the Onkyo receiver, with which I controlled the sound levels of all the Video Acoustics speakers. A few of the motion pictures I viewed (not always in their entirety, because of time constraints) were *Field of Dreams*, *Romancing the Stone*, and *Return of the Jedi*, all of which have soundtracks encoded for Dolby Surround. The surround effects were particularly effective as processed by the Onkyo receiver's Dolby Pro-Logic circuitry and reproduced by the Video Acoustics loudspeakers.

I suspect one factor inhibiting people from creating their own home theater is the task of choosing mutually compatible subwoofers and front, center, and surround speakers. In this context, that involves not only acoustical compatibility but aesthetic compatibility as well. Happily, the Video Acoustics system takes care of both. Having been designed as an integrated system, the speaker components work well together and maintain an overall sound balance that is ideal for the home theater environment. I would mention, too, that even when I was listening to stereo (using only the front bookshelf speakers and the subwoofer), sound quality was excellent, with extended bass response that belied the subwoofer's small size.

All of the units in my sample system were finished in genuine oak veneer, making them visually acceptable in rooms furnished in a wide variety of styles, from traditional to ultra-modern. If you are just starting out in your quest for a home theater system and aren't faced with the problem of having to match additional loudspeakers to an existing stereo pair, so much the better. But even if you currently own a pair of loudspeakers, once you audition the full Video Acoustics system you may well decide to relegate that "old" pair of speakers to a second stereo-only listening room and reserve the Video Acoustics system for your home theater.

Leonard Feldman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CLASSICAL RECORDINGS

JOHN ADAMS

THE DEATH OF KLINGHOFFER

ANTHONY DAVIS

X

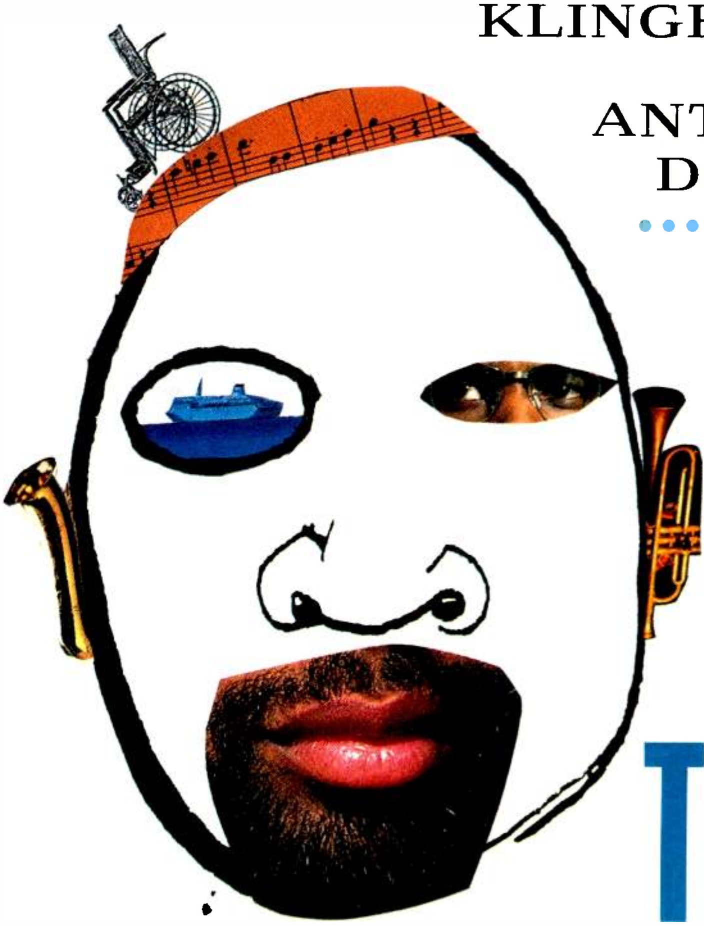

Illustration: Scott Menchin

Adams: The Death of Klinghoffer
Vocalists; Orchestra of the Opéra de Lyon, Kent Nagano
ELEKTRA NONESUCH 979281-2, two CDs; DDD; 2:15:13

Davis: X, The Life and Times of Malcolm X
Vocalists; Episteme; Orchestra of St. Luke's, William Henry Curry
GRAMAVISION R2-79470, two CDs; DDD; 2:38:00

TWO NEW OPERAS PRESENT STORIES BASED ON MODERN TRAGEDIES.

The Germans would apply to both these works the term *Zeitoper*, an opera written on a contemporary theme. They do have that in common, certainly, but their styles could hardly vary more. John Adams, who successfully emerged from the school of minimalism that still bogs down and stultifies the talent of Philip Glass, has used almost unalloyed fundamental and conventional harmonies to bring alive the tragic story of the Palestinian terrorists' hijacking of the cruise ship *Achille Lauro* and the killing of Leon Klinghoffer, the wheelchair-bound American Jew named in the title. Anthony Davis, a gifted African-American composer who has graced the faculties of Cornell, Yale, and Harvard, successfully combines elements of dodecaphony and jazz to deal with the life story of one of Black Liberation's most charismatic and still controversial figures.

Alice Goodman, as she did with Adams' first opera, *Nixon in China*, has once again supplied his libretto; with that opera, I held a minority opinion that she had done him no favor, and I find her contribution here no improvement. Any successful libretto, because of the extreme concentration opera demands of language, requires the maximum possible clarity for the purpose of accurate hearing—whereas Goodman's text here, even when read, distracts from the music instead of reinforcing it. That music will not overtax even the conservative listener, but repeatedly Adams' accomplishments with predominantly simple means prove extremely effective.

Davis' improbable musical synthesis crackles throughout with both tension and anger. So many composers who choose the 12-tone way seem to forget the importance of rhythm, but not Davis: He propels his story along powerfully with fiercely energetic, frequently asymmetric rhythms often evocative of the tension Leonard Bernstein so skillfully created in the scene before the two street gangs' rumble in *West Side Story*. It may seem paradoxical in view of the duplex American heritage of African-American music—spirituals and jazz—but Davis here remains faithful to the international, cerebral nature of Arnold Schoenberg's atonality. When his own Episteme ensemble contributes dashes of vaguely jazzy spice and coloration, they derive more from timbre than

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from melody and harmony, in a way familiar to anyone who knows Gunther Schuller's efforts in a similar direction.

The Death of Klinghoffer sizes up as humanistically engaged but politically impartial: Its fundamental situation deals directly with the Arab-Israeli dilemma, but anyone who might expect Goodman to have taken an anti-Arab approach should think again. The opera's fundamental thesis deals with man's inhumanity to man, and in that way lifts this work above any constriction of time or place into the truly universal. It does grieve over the utterly senseless murder of an accidental victim coincidentally Jewish, but in doing so it inveighs against the elemental barbarism of aspiring toward any political ends with violent means.

X, The Life and Times of Malcolm X, naturally, presents its title character as a hero and militantly takes his part. It opens with a scene—no doubt one of many—that left an indelible impression on the child Malcolm Little in Lansing, Michigan, in 1931: He and his mother get word that a white mob, after attacking the Rev. Little, left him lying on the tracks where a streetcar has cut him in half. The opera ends in Harlem in 1965, where Malcolm X, only 40 years old, is shot down. Davis has given his violent story a sometimes appropriately violent but highly effective score.

Musically, both recordings rank high. Adams has reengaged some of his *Nixon* singers, familiar with his style and thoroughly at home in it. Kent Nagano, the young, ethnically Japanese Californian now making a major career not only in Lyon but also in London and Manchester, keeps both music and drama taut at all times. The singers in the Davis opera—apparently an all-black undertaking—sound totally secure in even the most difficult passages, and their uniform security of pitch and clarity of enunciation contribute importantly. *Paul Moor*

Richard Danielpour: First Light; The Awakened Heart; Symphony No. 3
Faith Esham, soprano; Seattle Symphony and Chorale, Gerard Schwarz
DELOS DE 3118

These three recent works by the young American composer are distinguished by brilliant instrumental sonorities and the contrast of quietly lyrical song with motoric dance rhythms. Richard Danielpour honors tradition but has found a fresh and uplifting voice in his music, whether involving a vocal part or not.

"The Awakened Heart" is a triptych for orchestra, inspired by meditation on the path to inner freedom. The Symphony is also about the composer's inner growth, evolving from his reading of *A Course in Miracles* (Helen Schuman); the lyrics come from this book. The chorus, heard only in the coda, is hidden from the audience's view. Gerard Schwarz's players sound comfortable and confident, and John Eargle's warm, wide-range engineering serves the music well. *John Sunier*

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Illustration: Scott Menchin

DiY

VARIOUS ARTISTS

DiY
Various Artists
RHINO R2-71171 to R2-71179, nine CDs
Sound: B+ to C,
Presentation: A to C

On one hand, the folks at Rhino are known to dredge up all the cheesy music that was once the domain of K-Tel. On the other hand, they're pop history's established major-domos, honoring legends like Aretha Franklin, Jackie Wilson, and Jack Kerouac with boxed sets par excellence. On both hands, the Rhino nostalgia trip is like the character in that Elvis Costello song—a "deep, dark, truthful mirror" that mercilessly confronts the listener's psyche with the harsh reality of age and, in this reviewer's case, the fear of diminishing youth.

DiY, as in *Do it Yourself*, is Rhino's continuing survey of punk/New Wave rock 'n' roll and the skinny tie, Mohawk coif, and safety-pin-as-fashion-statement era, a.k.a. the late '70s and early '80s. Last year, Rhino began with the acclaimed Stiff Records retrospective, mining this genre as it appeared on that legendary British label. With *DiY*, the angle is different. Its nine separate volumes strive to place perspective on that single underlying ethos of alternative rock 'n' roll during this period, "Do it yourself." This was the universal call to arms for rebellious, frustrated, and sick-of-it-all youth to partake in rock's splendor: Go and pick up that guitar, start a band, start a fanzine, press your own album or single, become a legend. Although there exists to this day an organized coalition of independent musicians who are exponents of particular undergrounds or subcultures, the DiY phenomenon is basically no different than indie rock.

Rhino's *DiY* series is almost as much a tribute to college and alternative radio as it is to the sound and fury of punk-era rock 'n' roll, exposing the incredible diversity (almost a disparity) of rock during this period. That punk, quirky Farfisa-driven New Wave, English pub rock, and American power pop can coexist in a retrospective such as *DiY* is tenable if only for the fact that this music coalesced on alternative radio. Of course, these artists were also united in a shared spirit of anti-societal fashion and rebellion.

DiY encompasses two discs each of British punk from 1976 to 1978, Brit-pop from 1976 to 1979, and American power pop of the late '70s, as well as one disc each of New York's late-'70s punk/alternative scene, L.A.'s late-'70s bands, and Boston's scene from 1975 to 1983. In somewhat predictable fashion, the major players are represented with their biggest hits—The Jam with "In the City," The Sex Pistols with (surprise, surprise!) "Anarchy in the U.K.," and so on. Rare and unreleased demos give the series some added cachet if (and only if) you're into rare and unreleased demos. There are some notable omissions, such as The Clash, Jonathan Richman, Talking Heads, Graham Parker, and Dave Edmunds. This is largely due to licensing problems.

Some discs convey their premise more eloquently than others, *Blank Generation—The New York Scene (1975–1978)* in particular. Compiling artists like The Ramones, Mink DeVille, Television, and so many others onto one CD has to be the next best thing to being at CBGB's on every Saturday night in 1978. Conversely, *We're Desperate—The L.A. Scene (1975–1979)* covers L.A. punkdom before it peaked in the

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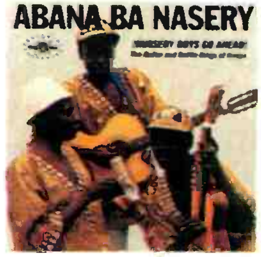
early to mid-'80s. Thus, bands like The Blasters, Black Flag, Circle Jerks, and Fear are omitted. Early-period X is the disc's saving grace. The Boston compilation and the American power-pop discs are dragged down by some dated (as opposed to timeless) cuts that cannot transcend their '70s-isms (Fotomaker and Billy Squier's band, Piper, are two of the culprits).

Has Rhino gotten in over its head with this series? Perhaps the question is whether anyone can really succeed in translating the sociological *and* musical impact of rock 'n' roll via CD compilations and nice annotation. Those who lived and breathed the music of this era will likely see *DiY* as slickly marketed product (it's not the *Trouser Press*, nor is it a virgin copy of *Never Mind the Bollocks Here's the Sex Pistols*). Yet for those who either missed out on punk entirely or turned 18 when all that was left was the embers, *DiY* will be a more than adequate history lesson. All hype aside, the music is what counts, and this is where *DiY* succeeds or fails—you decide.

Mike Bieber



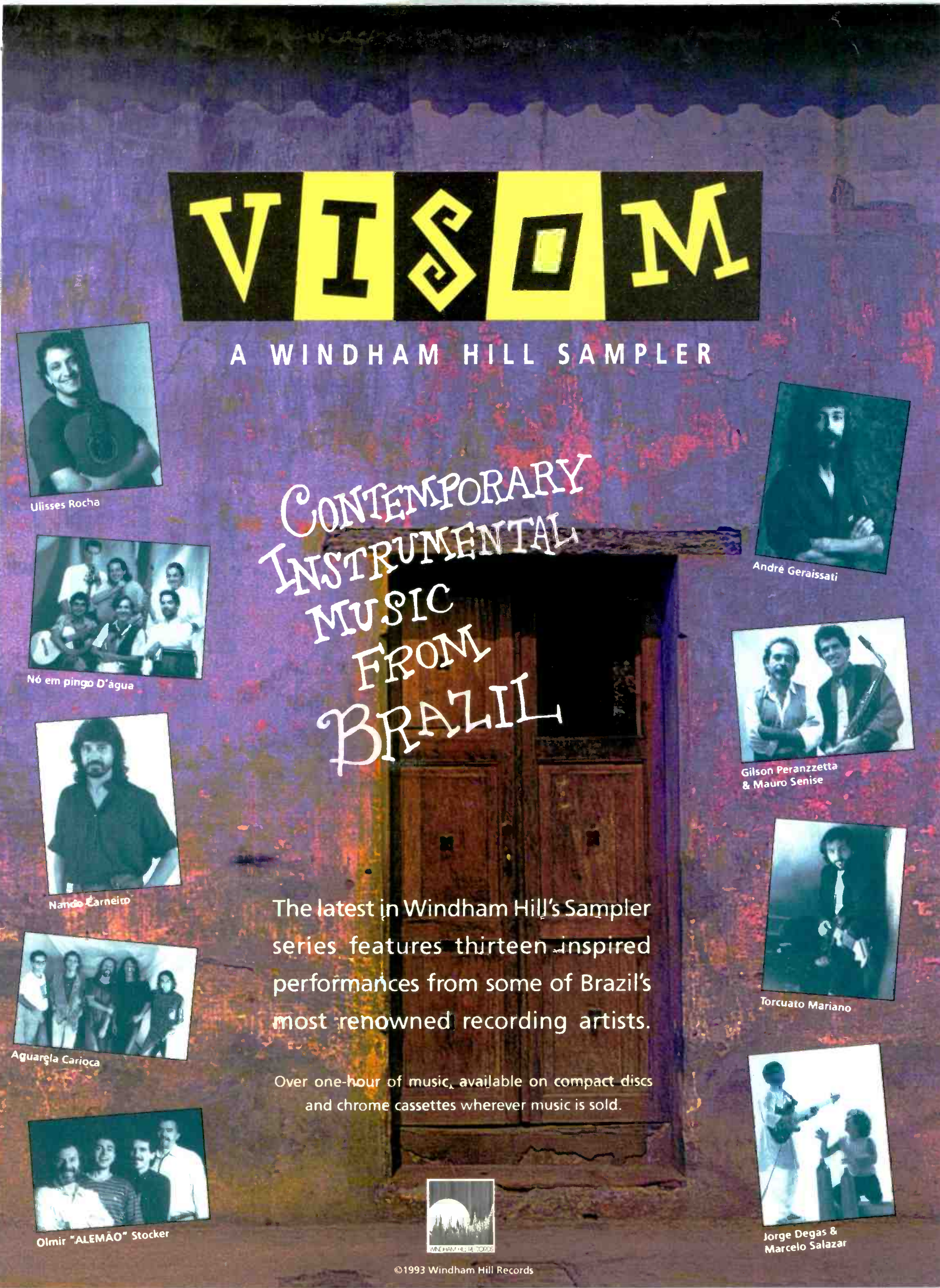
!Nursery Boys Go Ahead!
Abana Ba Nasery
GREEN LINNET GLCD 4002

Abana Ba Nasery have been singing and entertaining in their native Kenya for nearly three decades. On their U.S. debut, the trio continues to combine ebullient harmonies with acoustic guitars and the washboard-percussion effect of a ribbed Fanta soda bottle. This release marks a step forward, as the trio is joined by an international coterie of guests including Irish guitarist Ron Kavana, members of Britain's Oyster Band, and trumpeter Expensive Mustapha and multi-instrumentalist Hijaz Mustapha (of 3 Mustaphas 3). Thus, building on the foundation of chirping guitars, cicada-like bottle, and short, mellifluous vocal phrases are Arabic horns and touches of Irish jig. *!Nursery Boys Go Ahead!* is a lovely, gentle, and moving album. (Green Linnet, 43 Beaver Brook Rd., Danbury, Conn. 06810.) *Michael Wright*

Back to the Light
Brian May
HOLLYWOOD HR-61404-2

As he admits in his own liner notes, this is more a workbook than an integral Brian May solo album. Some of the recordings go back as far as 1980, and all were made during a stressful time, encompassing the deaths of both Queen bandmate Freddie Mercury and May's father. So we'll forgive Brian for sometimes oversinging and for making the odd song sound like second-rate Rainbow, because there's enough of his fine guitar here—intelligent leads, artfully layered figures—to remind veteran fans of regal days. And you gotta love those good old-fashioned power chords in "The Dark" and "Love Token." Listening tip: Play the album at a moderate volume through headphones, allowing '70s subtleties to slice through the '90s bombast.

Ken Richardson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THE MALCOLM X JAZZ SUITE

TERENCE BLANCHARD

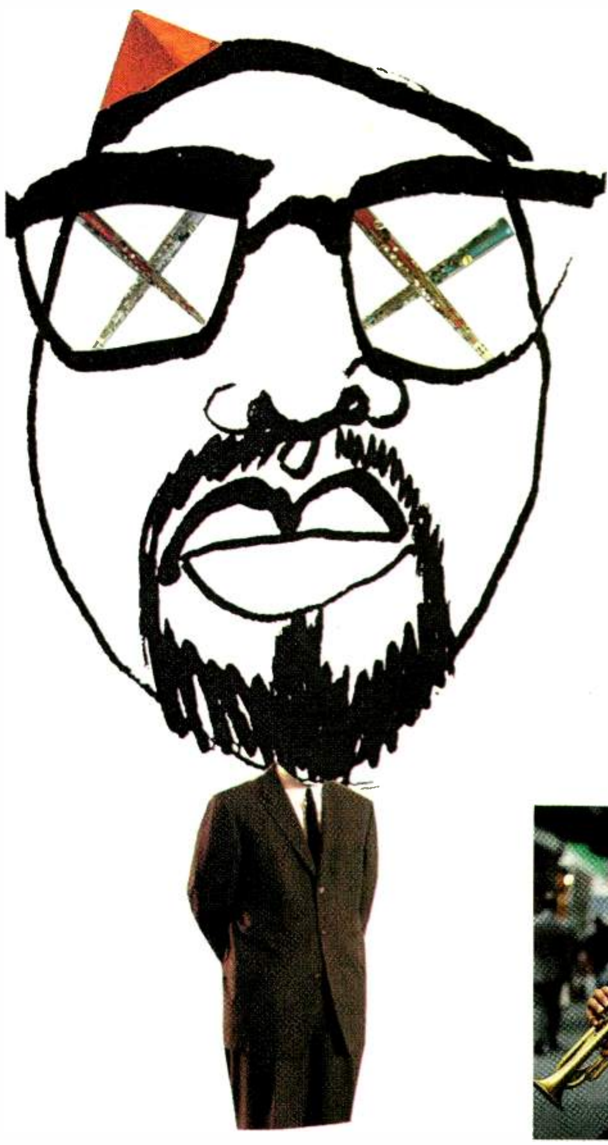


Illustration: Scott Menchin

The Malcolm X Jazz Suite
Terence Blanchard
COLUMBIA CK 53599,
CD; 73:25
Sound: A–, Performance: A–

Like most film scores, Terence Blanchard's music for Spike Lee's *Malcolm X* was episodic and often resorted to Hollywood orchestral formulas of emotional manipulation. But taking those same themes, Blanchard has made an album that's more film noir than Hollywood bright. The moods are dark, and solos emerge out of shadows.

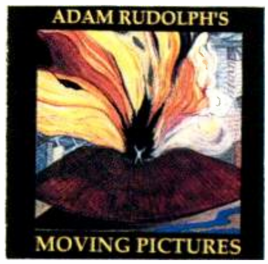
It's an ensemble effort, with trumpeter Blanchard and tenor saxophonist Sam Newsome tracking each other, interweaving lines, and veering off into solos. Blanchard tends to be hell-raising, with more of a debt to Freddie Hubbard than to Miles Davis. Newsome has a duskier hue, recalling the smoke-filled rumble of Dexter Gordon.

Photograph: ©David Gahr

There's a searching, probing edge to this music that sets it apart from most of the retro-jazz movement. Even though pianist Bruce Bath recalls Thelonious Monk's economy of notes with a slow-motion grind, it belies his intricate melodic structures and unusual chord voicings that cut in ragged diagonals. Just as Monk remains forever modern, Bath lends an air of urbanity to these sessions.

The references tell you that Blanchard and associates aren't breaking new ground. There's not much to separate this from any of a hundred Blue Note or Prestige straight-ahead sessions from the '50s and early '60s. But they play it like they're discovering it for themselves, and Blanchard is proving himself a gifted composer and arranger, capable of creating atmospheres that linger.

John Diliberto



Moving Pictures
Adam Rudolph
FLYING FISH 70612

Percussionist Adam Rudolph composes vivid, atmospheric soundtracks using jazz, blues, Middle Eastern, African, and Asian motifs over grooving rhythms, all on traditional acoustic and high-tech electric instruments. *Moving Pictures* comprises 18 tracks featuring Rudolph's hand drums, sampled percussion, and didjeridoo. Appearing on the album are guitarist Wah Wah Watson and Indian violinist Shankar, along with saxes, trumpet, concert harp, shofar, and wordless vocals, all thoroughly integrated and precipitously balanced—hushed, then as clamorous as the Istanbul grand bazaar. But rather than evoke a particular place or time, *Moving Pictures* is like successive dreams in which common images appear by surprise: Fascinating, if vaporous.

Howard Mandel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- Home Theater Special: Line doublers, projection and satellite TV, A/V furniture, and a preview of Philips' widescreen TV!
- DCC and MD: How the new digital formats stack up
- Head-to-Head: B&W, Infinity, KEF, Boston Acoustics, Polk, and Sonance in-wall speakers tested—*in a wall!*
- 3DO and Pioneer throw their hats in the interactive ring
- Reviews: Lexicon CP-3 surround processor, Marantz CD-11 MkII CD player, Denon AVR-2000 A/V receiver, Definitive Technology BP2 satellites, and *twelve* more products!

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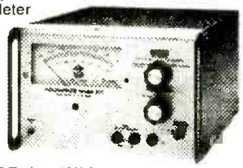

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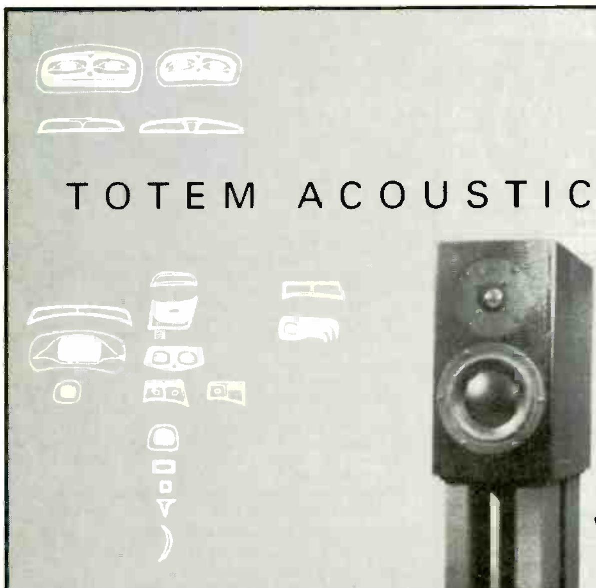

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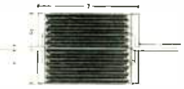

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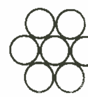

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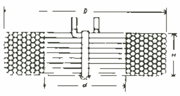

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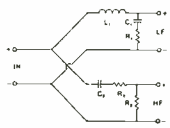

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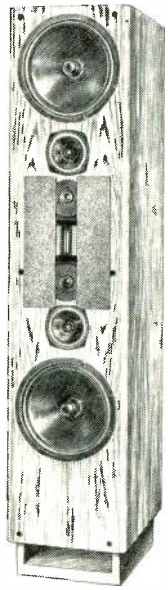

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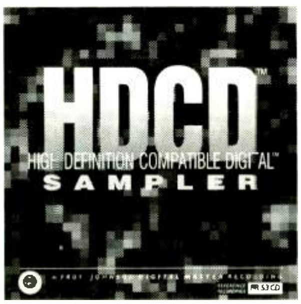

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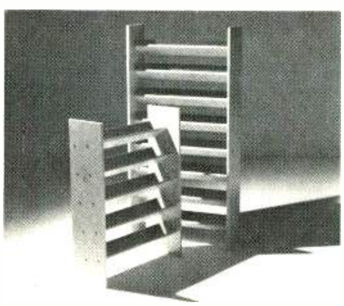

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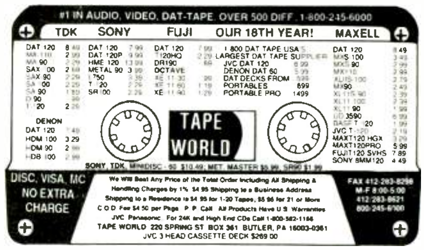

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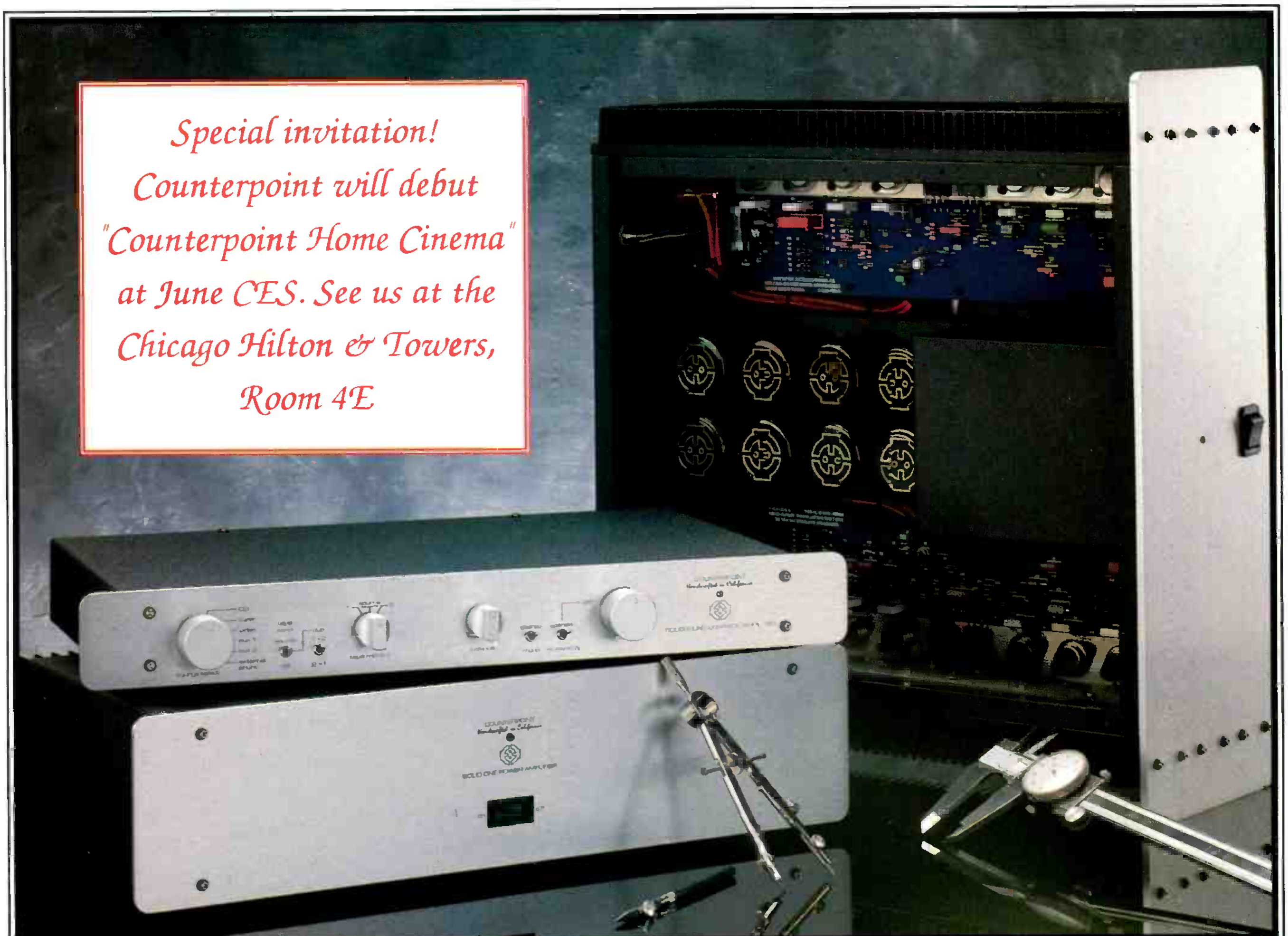

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